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FINAL

Interim Measures Work Plan
Expanded Bioventing System
SWMU 55 (IRP Site FT-03)

Charleston Air Force Base
South Carolina

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

437 CES/CEV
Charleston Air Force Base
South Carolina

April 1997

PARSONS
PARSONS ENGINEERING SCIENCE, INC.
401 Harrison Oaks Blvd., Suite 210 • Cary, North Carolina 27513

AQM01-03-0435

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FINAL
INTERIM MEASURES WORK PLAN
EXPANDED BIOVENTING SYSTEM
SWMU 55 (IRP SITE FT-03)
CHARLESTON AIR FORCE BASE, SOUTH CAROLINA

Prepared for

Air Force Center For Environmental Excellence

Brooks Air Force Base, Texas

And

437 CES/CEV

Charleston Air Force Base, South Carolina

April 1997

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Cary, North Carolina 27513

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AFFF	aqueous film forming foam
ARAR	applicable or relevant and appropriate regulations
AVG.	average
bgs	below ground surface
Bldg.	building
bls	below land surface
BTEX	benzene, toluene, ethylbenzene, xylenes
°C	degrees Celsius
CAP	corrective action plan
CMS	corrective measures study
COC	chemical of concern
CO_2	carbon dioxide
DIA.	diameter
ES	Engineering-Science, Inc.
ft	feet (foot)
ft/ft	foot per foot
ft^2/day	feet squared per day
HP	horsepower
IMWP	interim measures work plan
IRP	Installation Restoration Program
mg/kg	milligrams per kilogram
MP	monitoring point
MPA	monitoring point A
MPB	monitoring point B
MPC	monitoring point C
MPD	monitoring point D
MPE	monitoring point E
MPF	monitoring point F
msl	mean sea level
O&M	operations and maintenance
O_2	oxygen
PAH	polynuclear aromatic hydrocarbons
Parsons ES	Parsons Engineering Science, Inc.
PCB	polychlorinated biphenyls
P&ID	piping and instrumentation diagram
PID	photoionization detector
ppb	parts per billion
ppmv	parts per million by volume
PVC	polyvinyl chloride
RBC	risk-based concentration

RBCA	risk-based corrective action
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RI/FS	Remedial Investigation/Feasibility Study
SAIC	Science Applications International Corporation
SCDHEC	South Carolina Department of Health and Environmental Control
scfm	standard cubic feet per minute
SCH.	schedule
SVOC	semi-volatile organic compound
SWMU	solid waste management unit
TBC	to be considered
TD	total depth
TKN	total Kjeldahl nitrogen
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
TVH	total volatile hydrocarbons
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
µg/L	micrograms per liter
VMP	vapor monitoring point
VOC	volatile organic compound
VW	vent well

SECTION 1

INTRODUCTION

This interim measures work plan (IMWP) presents the scope for an expanded bioventing system to conduct *in situ* treatment of the remaining fuel-contaminated soils at solid waste management unit (SWMU) 55, also known as Installation Restoration Program (IRP) Site FT-03 (former Fire Protection Training Area No. 3), Charleston Air Force Base (AFB), South Carolina. Hereafter in this IMWP document, SWMU 55 will be referenced as Site FT-03. A one-year bioventing pilot study previously conducted at this site had successful results in reducing fuel hydrocarbons in soils. Activities associated with the proposed system expansion will be performed by Parsons Engineering Science, Inc. (Parsons ES) for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under contract F41624-92-D-8036, 0017. The primary objectives of the bioventing system upgrade are to:

- Deliver oxygen to additional areas of the site that have subsurface soils contaminated with fuel hydrocarbons that did not receive treatment during the one-year pilot study;
- Provide additional characterization data that can be used for site closure;
- Continue *in situ* remediation of fuel-contaminated soils by injecting atmospheric air into the soils to promote aerobic fuel biodegradation processes; and
- Sustain *in situ* aerobic fuel biodegradation until hydrocarbon-contaminated soils within the unsaturated zone are remediated to below regulatory-approved standards.

During October 1992, a horizontal air injection vent well (VW) and four vapor monitoring points (VMPs) were installed on the north side of the burn pit to conduct a bioventing treatability study. From November 1992 through November 1993, an extended bioventing pilot test was performed at Site FT-03 to determine if *in situ* bioventing would be a feasible cleanup technology for the fuel-contaminated soils in the vadose zone. Due to the successful results of the one-year pilot test, the pilot-scale system has continued operation from the end of the one-year pilot test to the present time. As described in this work plan, system expansions are planned to remediate unsaturated soils on the south side of the burn pit. Further details on the pilot test procedures and results can be found in the *Draft Interim Bioventing Pilot Test Results Report for Fire Protection Training Area Site FT-03, Charleston AFB, South Carolina* (Engineering-Science, Inc., 1993). A summary letter report of the one-year pilot test results, which was provided by AFCEE to the base, is included as an appendix in this document.

Following the one-year pilot test, soil and soil gas data confirmed significant fuel contaminant reduction in the pilot test treatment area. Laboratory results from soil and soil gas samples showed significant reductions in total volatile hydrocarbons (TVH) in soil gas, and significant reductions in total recoverable petroleum hydrocarbon (TRPH)

concentrations in soil. Concentrations of benzene, toluene, ethylbenzene, and xylenes (BTEX) in the soil and soil gas were initially low at the site. However, BTEX concentrations were reduced to nondetectable levels in all soil and soil gas samples that were collected at the end of the one-year pilot test. In addition, the one-year pilot test demonstrated that significant oxygen utilization and biodegradation are continuing in the pilot test area and that continued bioventing will promote additional fuel biodegradation in the source area. Further details of the pilot test results are presented in Section 3. The success of bioventing at this site supports the recommendation of an expanded (full-scale) bioventing system as the most economical approach of remediating the remaining hydrocarbon-contaminated soils at Site FT-03. Although the expanded bioventing system will be designed to remediate soil contamination in the unsaturated zone, biodegradation of fuel hydrocarbons in vadose zone soils is expected to reduce BTEX loading in groundwater by removing the primary source of these contaminants. Bioventing will be used as a presumptive remedy to reduce the source of organic fuel compounds in groundwater and as a means to further reduce potential risks associated with contaminants at this site.

Pilot test data have been used to design the full-scale bioventing system to remediate contaminated soils. The expanded system will consist of the existing VW and one additional horizontal VW (to be constructed) to deliver oxygen to the remaining areas having fuel-contaminated soils. Six new VMPs will also be constructed to monitor contaminant reduction and oxygen influence adjacent to the new horizontal VW. Additional soil and soil gas sampling will be conducted during these installations.

This document is divided into eight sections including this introduction, and one appendix. Section 2 discusses site background and includes a discussion of existing characterization data. Section 3 provides the results of the extended pilot test conducted at Site FT-03. Section 4 identifies the treatment area of the proposed expanded system; provides construction details of the expanded system; and recommends a proven, cost-effective approach for the remediation of the remaining hydrocarbon-contaminated soils at the site. Procedures for handling investigation-derived waste are described in Section 5, and Base support requirements are listed in Section 6. Section 7 provides key points of contact at Charleston AFB, AFCEE, and Parsons ES; and Section 8 provides the references cited in this document. A design package for the expanded bioventing system is provided in Appendix A. The AFCEE one-year pilot study summary report is provided in Appendix B. Appendix C contains a site Health and Safety Plan. Appendix D contains the written responses to regulatory comments to the Draft Final work plan.

SECTION 2

SITE BACKGROUND

2.1 SITE DESCRIPTION AND HISTORY

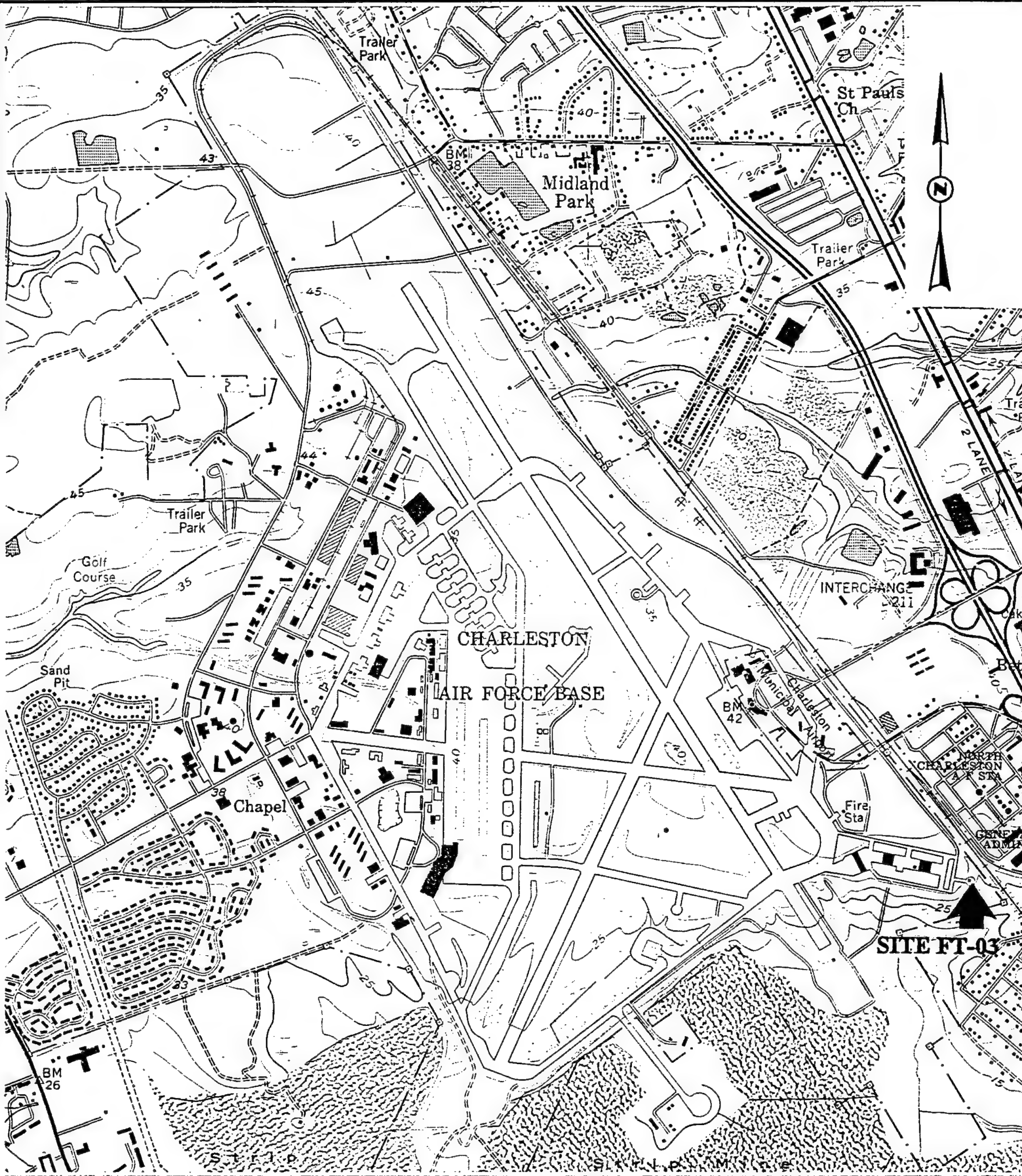
Fire Protection Training Area No. 3, also referenced as Site FT-03 and Solid Waste Management Unit (SWMU) #55, is located on the extreme southeastern part of Charleston AFB (see Figure 2.1). The 2-acre site was once used for controlled burning of flammable wastes during base fire training exercises. During its operation, the facility consisted of one burn pit surrounded by an earthern berm and lined with limestone gravel. A steel tank used as a mock aircraft was located inside the burn pit and a concrete building was located outside the burn pit on the southwest corner of the site. During fire training exercises, flammable liquids were sprayed on these structures and on the ground, ignited, and then extinguished using various agents such as aqueous film forming foam (AFFF), halon, and dry chemicals. It is reported that JP-4 jet fuel was the primary flammable liquid burned at the site; however, it is believed that other industrial wastes may have been burned when the facility was first established (Halliburton NUS, 1995). The site has not been used for fire training exercises since the early 1980's. It is currently overgrown and heavily wooded around its perimeter. The steel tank, concrete building, and remnants of the earthen berm are still present at the site.

2.2 PREVIOUS INVESTIGATIONS

A total of ten groundwater monitoring wells have been installed at Site FT-03. Seven of the groundwater monitoring wells were installed from 1985 through 1990 during two phases of remedial site investigations executed by Science Applications International Corporation (SAIC) and by Versar, Inc. As referenced by the Phase II Remedial Investigation/Feasibility Study (RI/FS) Report, Stage 2 (Versar, Inc., 1992), five of the original wells (3-1 through 3-5) reportedly had submerged well screens during several water level measuring events. Wells 3-6 and 3-7 were installed with screens reportedly above the water table. In addition to the monitoring well installation and sampling, other activities performed during this period included soil sampling, sediment sampling, surface water sampling, aquifer testing, and a soil gas survey. Total recoverable petroleum hydrocarbon (TRPH) concentrations as high as 7,770 milligrams per kilogram (mg/kg) were detected in shallow soils during these earlier investigations.

From 1992 through 1994, three additional monitoring wells (3-8, 3-9, B-7) were installed at the site by Halliburton NUS during a base-wide RCRA Facility Investigation (RFI). Well 3-8 was installed in between wells 3-3 and 3-6 to further delineate groundwater contaminants in the downgradient direction. Well B-7 was installed upgradient of Site FT-03 to monitor background groundwater conditions. Well 3-9, installed during 1994, was constructed as a deep well. This well was screened across the bottom 10 feet of the surfical aquifer to assess groundwater quality

Figure 2.1



Map Source: USGS (1958)
Ladson, South Carolina Quadrangle
(7.5 Minute Series)

2000' 1000' 0 2000'

Approximate Scale in Feet

Site Location Map

Site FT-03
Fire Training Area No. 3
Charleston AFB, South Carolina

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near the base of the surficial aquifer. Halliburton NUS conducted additional soil, sediment, and groundwater sampling and aquifer testing during the 1992-1994 RFI.

Parsons ES conducted a one-year bioventing pilot test at the site beginning in November 1992. A horizontal vent well, regenerative blower, electrical power supply, and four vapor monitoring points (MPA, MPB, MPC, and MPD) were installed at the site to conduct the test. Results of the initial bioventing testing are presented in the *Draft Interim Bioventing Pilot Test Results Report for Fire Protection Training Area Site FT-03, Charleston AFB, South Carolina* (Engineering-Science, Inc., 1993). Details of the bioventing test are discussed in Section 3 of this report and Appendix B contains a letter report summarizing the final results of the one-year pilot test. Figure 2.2 shows the locations of existing site features, monitoring wells, and pilot test installations presently located at Site FT-03.

Radian International (Radian) is currently completing additional RFI work and conducting a Corrective Measures Study (CMS) for SWMU 55 (Site FT-03). The scope of this work includes additional soil and groundwater investigations at the site.

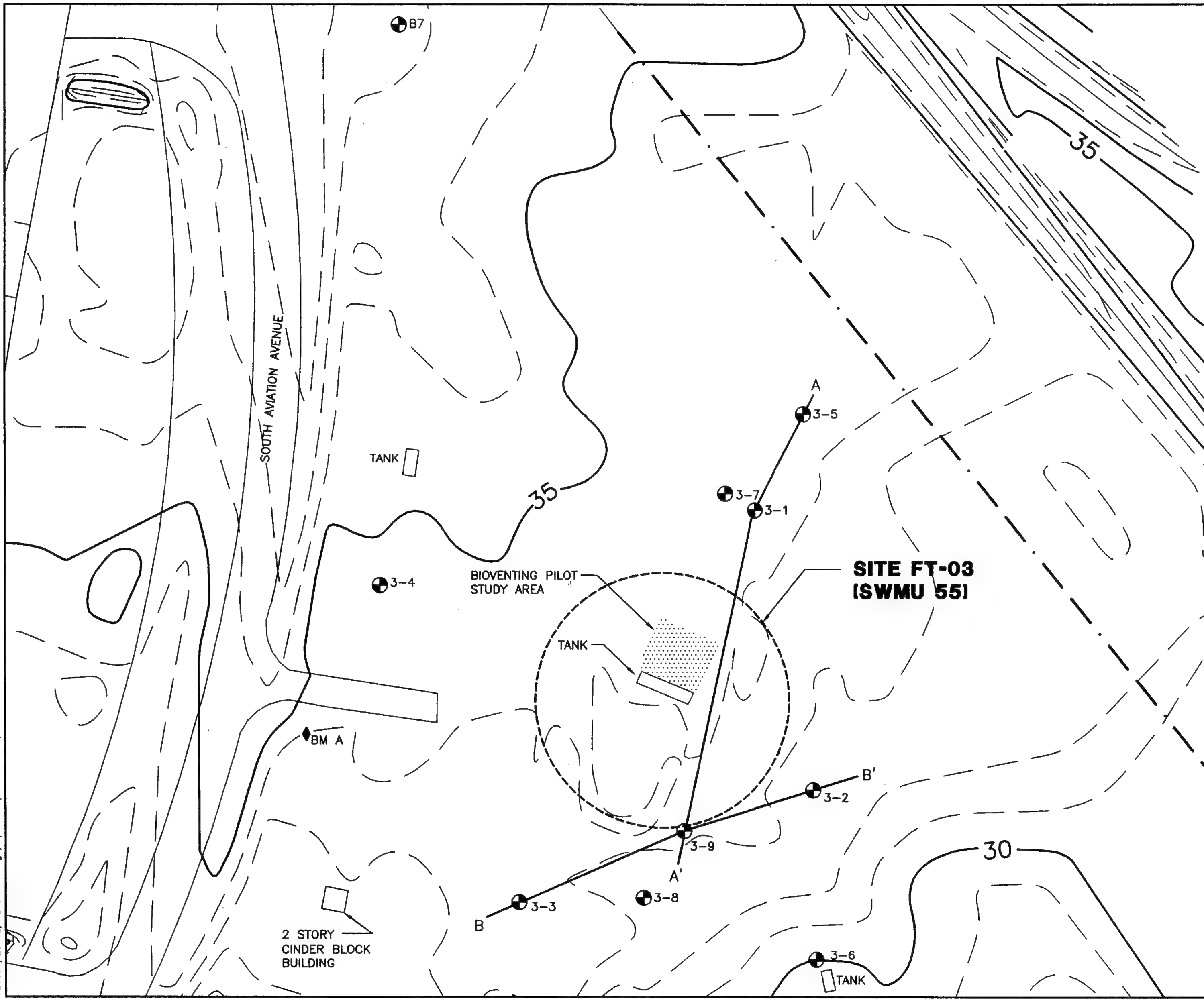
2.3 SITE GEOLOGY AND HYDROGEOLOGY

A more detailed discussion of the site lithology and hydrogeology can be found in the *Draft Interim Bioventing Pilot Test Results Report for Fire Protection Training Area Site FT-03, Charleston AFB, South Carolina* (Engineering-Science, Inc., 1993), and the *Draft RCRA Facility Investigation Report, Charleston AFB, South Carolina* (Halliburton NUS, 1995). Charleston AFB is located in the Lower Coastal Plain physiographic province of South Carolina. Sediments beneath the base are characterized as a thick sequence of interbedded sands, silts, and clays formed by fluvial and marine processes. These interbedded layers are grouped into regional formations and aquifers based on lithologic and water quality characteristics. Surficial soils around the base are generally sandy and highly permeable at shallow depths, but may contain zones of clay and organic deposits. The area is marked by low geomorphic relief.

The subsurface lithology was characterized across the site during previous investigations (Halliburton NUS, 1995). The shallow subsurface material was identified as part of the Ladson Formation, which consists of a fine to medium-grained sand with traces of silt, intermittent clays, and some clay stringers. Figures 2.3 and 2.4 show two hydrogeologic cross sections of the site developed by Halliburton NUS (1995). The Cooper Marl Formation forms the base of the surficial aquifer, and was identified in borings at the site from 38 to 55 feet below ground surface (bgs). Unsaturated soil in the vicinity of Site FT-03 are primarily silty sand with traces of silt and clay. Fill material consisting of silt, sand, and crushed aggregate was encountered within the berm that surrounds the burn pit (Halliburton NUS, 1995). Remnants of the berm, which was constructed of soil and limestone aggregate, are still present at the site. The berm hinders surface drainage from the burn pit and the pit often contains several inches of standing water after precipitation events.

Groundwater in the surficial aquifer is encountered at an average depth of 4 feet bls in the vicinity of the burn pit on Site FT-03. The surficial aquifer consists of a silty

Figure 2.2



Site Map with Well Locations

Site FT–03
Fire Training Area No. 3
Charleston AFB, South Carolina

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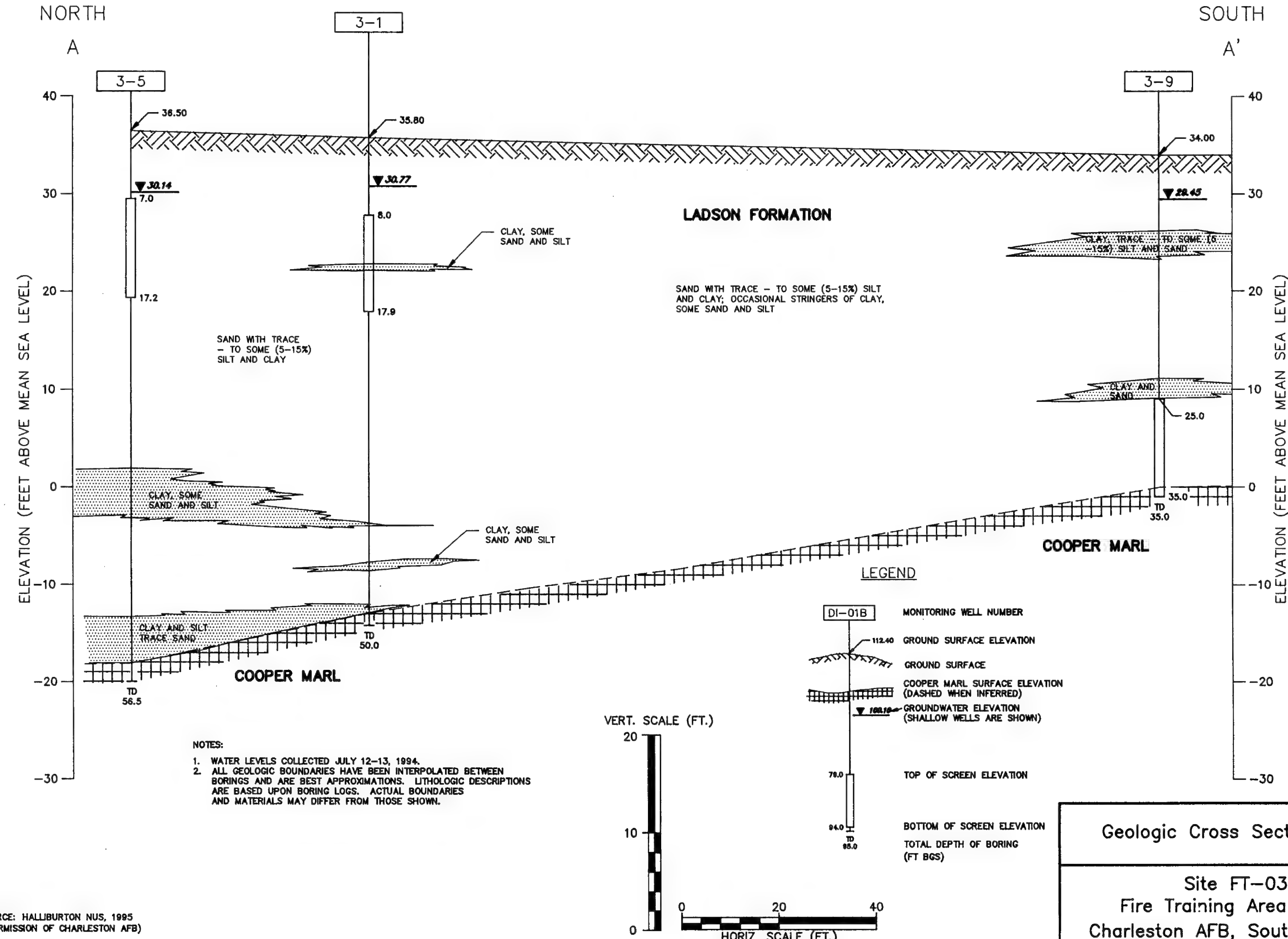
Figure 2.3



NOTES:

1. WATER LEVELS COLLECTED JULY 12-13, 1994.
2. ALL GEOLOGIC BOUNDARIES HAVE BEEN INTERPOLATED BETWEEN BORINGS AND ARE BEST APPROXIMATIONS. LITHOLOGIC DESCRIPTIONS ARE BASED UPON BORING LOGS. ACTUAL BOUNDARIES AND MATERIALS MAY DIFFER FROM THOSE SHOWN.

MAP AND DATA SOURCE: HALLIBURTON NUS, 1995
(REPRODUCED BY PERMISSION OF CHARLESTON AFB)

Geologic Cross Section A-A'

Site FT-03
Fire Training Area No. 3
Charleston AFB, South Carolina

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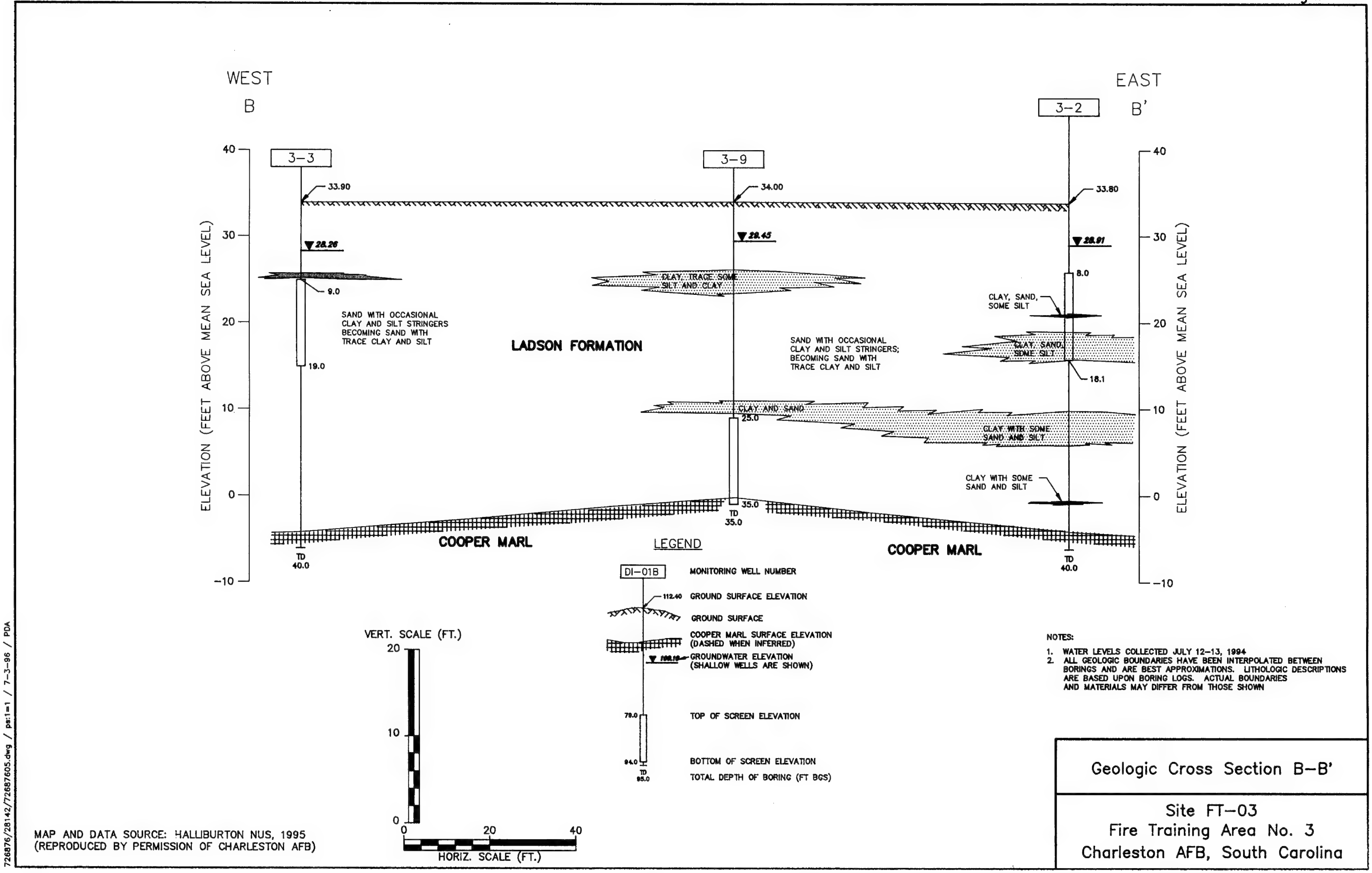

WEST
B
EAST
B'
3-3
3-9
3-2
33.90
34.00
33.80
28.26
28.45
28.91
9.0
19.0
8.0
18.1
25.0
35.0
TD 40.0
TD 35.0
TD 40.0
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
40
30
20
10
0
-10
SAND WITH OCCASIONAL CLAY AND SILT STRINGERS BECOMING SAND WITH TRACE CLAY AND SILT
LADSON FORMATION
CLAY, TRACE SOME SILT AND CLAY
SAND WITH OCCASIONAL CLAY AND SILT STRINGERS; BECOMING SAND WITH TRACE CLAY AND SILT
CLAY, SAND, SOME SILT
CLAY, SAND, SOME SILT
CLAY AND SAND
CLAY WITH SOME SAND AND SILT
CLAY WITH SOME SAND AND SILT
COOPER MARL
COOPER MARL
LEGEND
DI-01B
MONITORING WELL NUMBER
112.40
GROUND SURFACE ELEVATION
GROUND SURFACE
COOPER MARL SURFACE ELEVATION (DASHED WHEN INFERRED)
GROUNDWATER ELEVATION (SHALLOW WELLS ARE SHOWN)
79.0
TOP OF SCREEN ELEVATION
94.0
BOTTOM OF SCREEN ELEVATION
TD 95.0
TOTAL DEPTH OF BORING (FT BGS)
VERT. SCALE (FT.)
HORIZ. SCALE (FT.)
NOTES:
1. WATER LEVELS COLLECTED JULY 12-13, 1994
2. ALL GEOLOGIC BOUNDARIES HAVE BEEN INTERPOLATED BETWEEN BORINGS AND ARE BEST APPROXIMATIONS. LITHOLOGIC DESCRIPTIONS ARE BASED UPON BORING LOGS. ACTUAL BOUNDARIES AND MATERIALS MAY DIFFER FROM THOSE SHOWN
MAP AND DATA SOURCE: HALLIBURTON NUS, 1995
(REPRODUCED BY PERMISSION OF CHARLESTON AFB)
Geologic Cross Section B-B'
Site FT-03
Fire Training Area No. 3
Charleston AFB, South Carolina
726876/28142/72687605.dwg / ps:1=1 / 7-3-96 / PDA

sand matrix. Precipitation is the primary mode of recharge at the site. The water table fluctuates in response to precipitation and shows seasonal elevation changes. After extended periods of precipitation, the water table has been observed as shallow as 2 feet bls in the burn pit area (Engineering-Science, Inc., 1993).

The predominant direction of shallow groundwater flow is to the south and southeast toward a tributary of Filbin Creek. Potentiometric maps provided in previous site reports indicated little seasonal variation with respect to groundwater flow direction (Versar, 1992; Halliburton, 1995). An average groundwater gradient of approximately 0.015 ft/ft was reported. Halliburton NUS performed two aquifer pump tests at the site and monitored the drawdown responses at eight monitoring wells. An average aquifer transmissivity value of 809 ft^2/day was calculated using results from both tests. Aquifer storativity ranged from 0.016 to 0.00006, with an average value of 0.0006. An average hydraulic conductivity of 21 feet/day was calculated, based on an aquifer thickness of 38 feet. Based on these data and an estimated effective porosity of 0.30, the average linear groundwater flow velocity in the vicinity of Site FT-03 is 1.1 feet/day, or 380 feet/year (Halliburton NUS, 1995).

2.4 SITE CONTAMINANTS

The primary contaminants at this site are petroleum hydrocarbons, which were detected in the soils and groundwater at depths ranging from ground surface to about 30 feet bgs. TRPH maximum concentrations of 7,770 milligrams per kilogram (mg/kg) have been detected in the soils at a depth of 2 to 3 feet on the north end of the berm. Soil headspace VOCs were also detected in concentrations of 22,107 parts per billion (ppb) at this sampling point. Shallow sediment samples showed TRPH concentrations of 3,310 mg/kg during the earlier RI/FS investigations (Versar, 1992). Volatile organic compounds (VOCs) benzene, toluene, ethylbenzene, xylenes and several semi-volatile organic compounds (SVOCs) were detected in both soils and groundwater at the site. Chlorinated solvents have also been detected in soils and groundwater at low concentrations. Lead (dissolved and total) was also detected in groundwater and soils at the site (Halliburton NUS, 1995).

Initial soil sampling conducted by Engineering-Science prior to the one-year bioventing pilot test showed TRPH concentrations up to 2,200 mg/kg within shallow soils in the burn pit. Benzene was not detected in any of the soil samples collected but the compounds toluene, ethylbenzene, and total xylenes were detected in two of the three samples. Total volatile hydrocarbons (TVH) in soil gas ranged from 27 parts per million by volume (ppmv) to 790 ppmv. Ethylbenzene and xylenes also were detected at very low concentrations in soil gas samples (Engineering-Science, 1993).

During the 1992 RFI at Site FT-03, Halliburton NUS collected ten surface soil samples (<2 feet deep). Samples were analyzed for a combination of the following: volatiles, semivolatiles, TRPH, pesticides, polychlorinated biphenyls (PCBs), and inorganic constituents. Minimal SVOCs were detected in the surface soils. One sample contained elevated concentrations of lead (79.5 mg/kg) and chromium (241 mg/kg).

Seven subsurface soil samples (>2 feet deep) also were collected during the 1992 investigation. Samples were analyzed for a combination of VOCs, SVOCs, TRPH, pesticides, PCB, and inorganics constituents. BTEX and other VOC concentrations were generally low. The highest reported concentrations were 0.005 mg/kg (benzene), 0.004 mg/kg (ethylbenzene), 0.013 mg/kg (total xylenes), 0.012 mg/kg (methylene chloride), 0.014 mg/kg (tetrachloroethene), and 0.004 mg/kg (trichloroethene). The highest reported chromium and lead concentrations in subsurface soil were 19.3 mg/kg and 52.2 mg/kg, respectively.

Six groundwater samples were collected during the 1992 investigation and seven groundwater samples were collected during a subsequent 1994 sampling event. Samples were analyzed for a combination of VOCs, SVOCs, TPH, pesticides, PCB, metals and inorganics constituents. Concentrations of BTEX and other fuel-related VOCs were generally low or not detected in most wells. The highest detected VOC concentrations were 250 micrograms per liter (μg/L) benzene, 5 μg/L ethylbenzene, 10 μg/L vinyl chloride, 31 μg/L 1,2-dichloroethane, and 1 μg/L trans-1,2-dichloroethene. The highest reported total chromium and lead concentrations in groundwater were 0.432 milligrams per liter (mg/L) and 0.915 mg/L, respectively. A more detailed discussion of the site contaminants can be found in the *Draft RCRA Facility Investigation Report, Charleston AFB, South Carolina* (Halliburton NUS, 1995).

As part of the RFI, Halliburton NUS conducted a baseline human health risk assessment for Site FT-03 in its current condition. The highest concentrations of chemicals detected in each medium at the site were compared to the base background results and to applicable or relevant and appropriate regulations (ARARs) or to be considered (TBC) action levels established as RCRA Subpart S Action Levels for the base. A list of chemicals of concern (COCs) was developed for each medium and the quantitative risk assessment was performed for each of the COCs. For soils, only chromium exceeded both background levels and ARAR/TBC levels and it was retained as a COC for further risk evaluation. A number of potential COCs were identified from the sediment sampling results and several pesticides exceeded base background and ARAR/TBC action levels. For groundwater, benzene and 1,2-dichloroethane were the only VOCs identified as COCs. Ten inorganic compounds exceeded base background and ARAR/TBC levels for groundwater and, of this total, seven metals were identified as COCs. Although it has been detected at this site, lead was not identified as a COC in any of the media. This site does not have an established ARAR/TBC, risk based concentration (RBC), or risk-based corrective action (RBCA) regulatory cleanup standard for TRPH in soil. The RBCs for COCs identified at the site will be further developed as part of the RFI/CMS performed by Radian.

SECTION 3

BIOVENTING PILOT TEST RESULTS

A one-year pilot test was conducted at Site FT-03 from November 1992 through November 1993 to determine if *in situ* bioventing would be a feasible cleanup technology for the fuel-contaminated soils within the unsaturated zone. The objectives of the initial bioventing pilot test were to:

- Assess the potential for supplying oxygen throughout the contaminated soil profile;
- To determine the rate at which indigenous microorganisms will degrade petroleum hydrocarbons when stimulated by oxygen-rich soil gas at this site; and
- To evaluate the potential for sustaining these rates of biodegradation until hydrocarbon contamination is remediated below regulatory-approved standards.

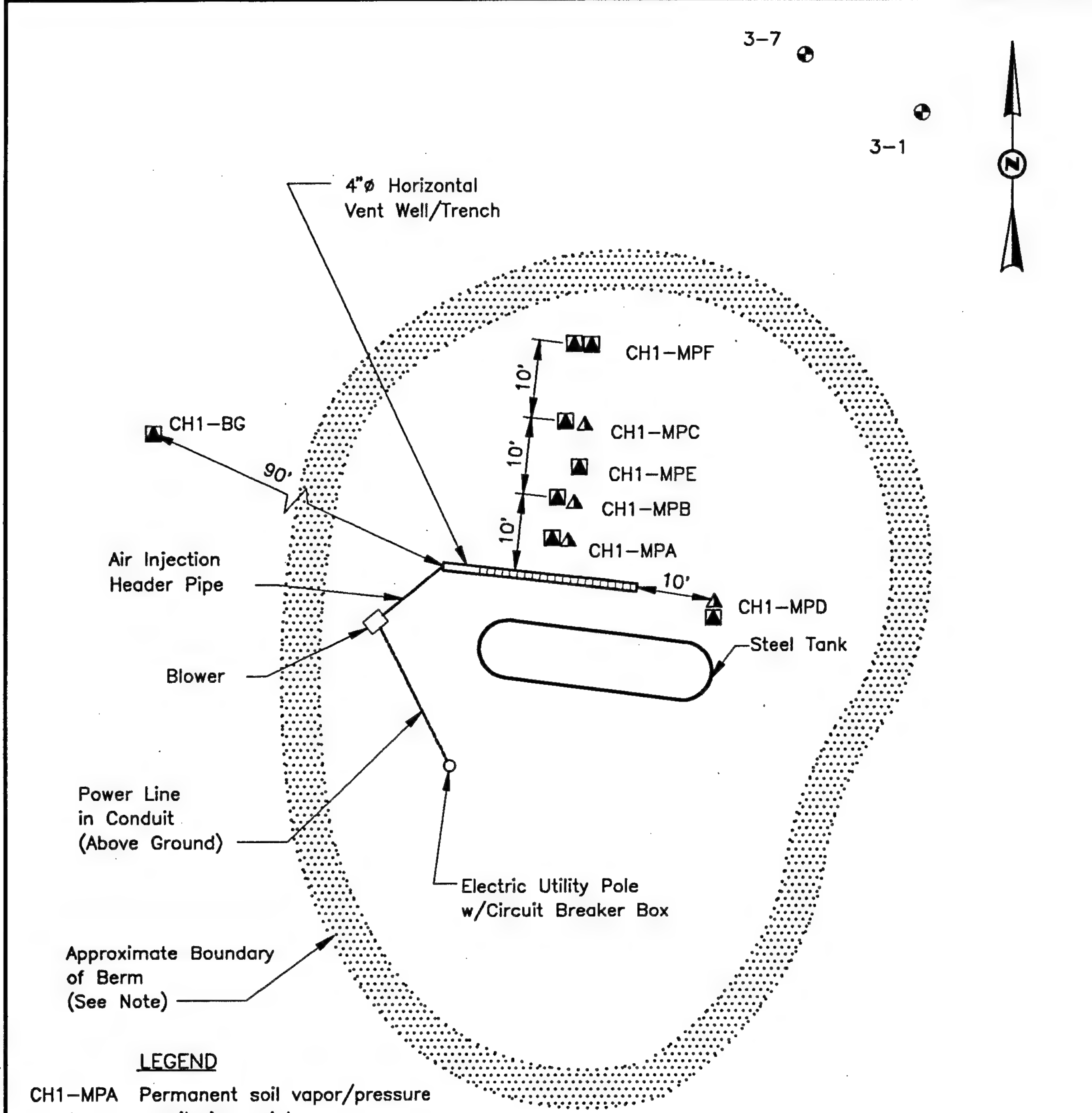
Due to the successful results of the one-year pilot test, the bioventing system has continued operation from November 1993 to the present to evaluate the effects of long-term bioventing at the site. Because bioventing has been demonstrated to be a feasible technology to remediate hydrocarbon-contaminated soils at Site FT-03, the pilot test data were used to design a full-scale remediation system to remediate additional areas at the site (see Section 4). Installation of a second horizontal vent well will remediate a larger area of soils and facilitate risk reduction for organic hydrocarbons in soils. Reduction of organic fuel contaminants in soil is expected to facilitate groundwater remediation indirectly by removing the contaminant source.

3.1 INITIAL PILOT TEST CONFIGURATION

A horizontal air injection vent well (VW) was installed on October 28, 1992 under the direction of Parsons Engineering Science, Inc. (formerly Engineering-Science, Inc.). Four permanent pressure/vapor monitoring points (VMPs) were also installed on October 29, 1992. The following sections describe in more detail the design, installation, and testing of the bioventing pilot test system used at Site FT-03.

One horizontal vent well, four permanent VMPs, and a blower unit in a weather-proof enclosure were installed at Site FT-03 for the extended bioventing test. Prior to conducting air permeability and respiration tests, shallow soil gas probes were installed adjacent to the permanent VMPs to serve as temporary VMPs. The temporary soil gas probes were installed to monitor soil gas conditions in very shallow soils (<2.5 feet deep), as an unseasonably high water table during the initial testing prevented utilization of the permanent VMPs. The unusually high water table at the site also prevented using existing groundwater monitoring wells for soil gas and pressure monitoring during the tests. A temporary soil gas probe was subsequently installed to serve as a background monitoring point. Figure 3.1 depicts the pilot test area with the

Figure 3.1



LEGEND

CH1-MPA	▲	Permanent soil vapor/pressure monitoring point.
CH1-MPA	◪	Temporary soil vapor/pressure monitoring point (soil gas probe).
CH1-BG	◪	Temporary background monitoring point.
3-7	⊕	Groundwater monitoring well.

NOTE: Soil berm has approximate elliptical dimensions and varying widths. Locations of tank, vent well, and utility pole within berm are estimated.

20' 10' 0 20'

Approximate Scale in Feet

Bioventing Pilot Test Installations

Site FT-03
Fire Training Area No. 3
Charleston AFB, South Carolina

locations of the permanent and temporary VMPs, the horizontal VW, and the air injection blower.

3.1.1 Air Injection Vent Well

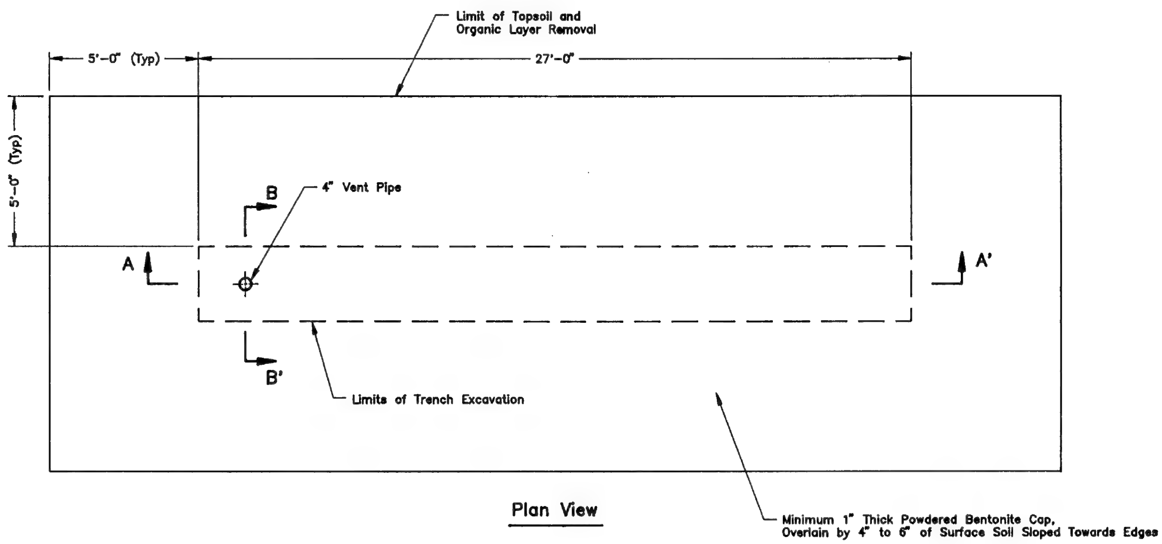
The air injection vent well was installed within the bermed area on the north side of the fire training pit as shown in Figure 3.1. The vent well was constructed in a shallow trench excavated in visibly contaminated, oxygen-depleted soils. Soils in the immediate vicinity of the trench were dark stained and contained strong hydrocarbon odors. A horizontal air injection vent well was installed at this site because the relatively shallow water table and limited vadose zone prevented the installation of a vertical vent well. Figure 3.2 shows the as-built construction details of the trench and vent well. On the date of the vent well/trench installation, water levels at Site FT-03 were approximately 4 feet bgs. Water level elevations observed during the pilot test were 1 to 2 feet higher than the historical normal water levels for that time of year as reported in previous IRP reports for this site (Versar, 1992). Consequently, the bottom of the horizontal vent well was installed at approximately 3.5 feet bgs to avoid the high water table conditions that existed in the burn pit. As-built construction and operating details for the horizontal air injection vent well are provided in the *Draft Interim Bioventing Pilot Test Results Report for Fire Protection Training Area Site FT-03, Charleston AFB, South Carolina* (Engineering-Science, 1993).

3.1.2 Permanent Monitoring Points

Four permanent VMPs were installed on October 29, 1992. Monitoring points MPA, MPB, MPC were installed perpendicular to the vent well axis at respective distances of 5, 10 and 20 feet, while the fourth point (MPD) was installed parallel to the vent well axis 10 feet from the east end of the vent well (see Figure 3.1). The permanent VMP boreholes were advanced using a decontaminated hand auger. Only one VMP screen was installed per borehole. Multi-depth VMP screens could not be installed at Site FT-03, as the shallow water table conditions would not accommodate construction of multiple bentonite and grout seals with adequate integrity.

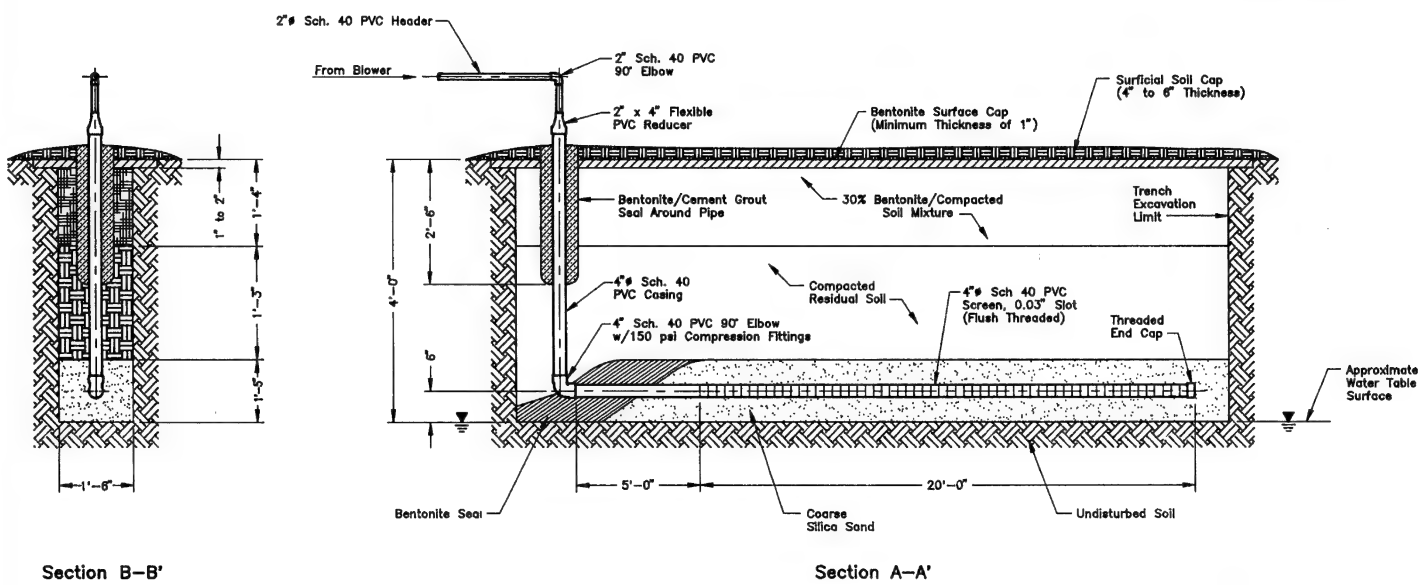
The four permanent monitoring points were constructed using 0.5-inch diameter PVC screens and casings installed in a 4-inch diameter borehole. Each VMP was constructed using a 6-inch section of 0.02-inch slot, schedule 80 PVC screen and schedule 40 PVC casing. The screened interval was surrounded by a gravel pack of #2 coarse silica sand. Thermocouples also were installed to measure soil temperature at the screened interval of monitoring points MPD-3.9 and MPA-3.5. Bentonite and grout seals were used to seal the annulus around the riser above the gravel pack. The top of each PVC riser was completed near the ground surface with a brass gas ball valve and a 3/16-inch hose barb. Each VMP was completed at the surface with a flush-mount metal well vault set in a concrete base. The lid of the metal well vault was set several inches above the ground surface, and the concrete base was sloped toward the edges to promote drainage of surface water away from the VMP. Figure 3.3 shows a typical construction schematic for the permanent VMPs at this site. Construction details listing the depths and screened intervals of each permanent VMP also are shown in Figure 3.3.

Figure 3.2



Notes:

1. Drawing is not to scale.
2. All fittings are threaded or compression type. No PVC cement was used.
3. Water table surface was 4.0 feet below original ground surface on 10/28/92.
4. Trench and vent well installed on 10/28/92.

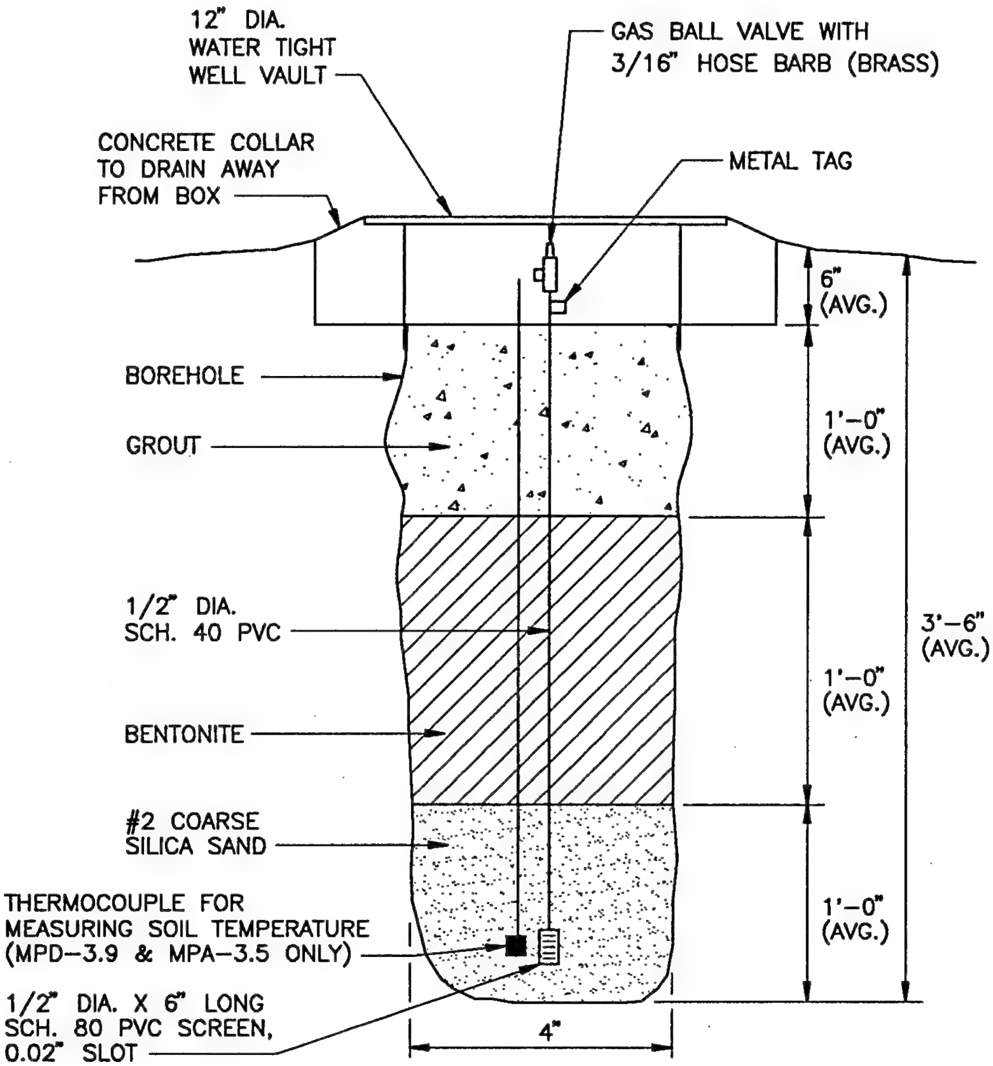


As-Built Schematic of Pilot Test Vent Well
Site FT-03 Fire Training Area No. 3 Charleston AFB, South Carolina

726876/28142/72687606.dwg / ps=1=60 / 7-3-96 / PDA

PARSONS ENGINEERING SCIENCE, INC.

Figure 3.3



DRAWING IS NOT TO SCALE

MONITORING POINT CONSTRUCTION SPECIFICATIONS

Monitoring Point No.	Borehole Depth (FT)	Screen Interval (Feet BLS)
MPA–3.5	3.5	2.5–3.0
MPB–3.5	3.5	2.5–3.0
MPC–3.25	3.25	2.6–3.1
MPD–3.9	3.9	2.8–3.3

As–Built Schematic of Permanent Vapor Monitoring Point

Site FT–03
Fire Training Area No. 3
Charleston AFB, South Carolina

726276/28142/72687607.dwg / ps:1=1 / 7-3-96 / PDA

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3.1.3 Temporary Monitoring Points

Eight temporary VMPs were installed in the Site FT-03 pilot test area to monitor shallow soil gas conditions during the tests (Figure 3.1). Five of the points, including the background monitoring point CH1-BG, were installed on November 9, 1992 prior to conducting the air permeability test. Three additional temporary VMPs (MPE and MPF) were installed after evaluating the air permeability test responses and before conducting the in-situ respiration test. One of the temporary monitoring points (MPE) was used to replace MPA-3.5, which began collecting water in the screens after prolonged heavy rains elevated the water table even further at the site.

The temporary VMPs were installed using an AMS Soil Gas Vapor Kit and dedicated soil vapor probes. The soil vapor probes were advanced adjacent to existing permanent VMPs to provide the shallow monitoring intervals (i.e. 1 to 2 feet deep) that could not be constructed in the boreholes using PVC screens and riser. With the exception of the background VMP, most of the soil vapor probes did not exceed a depth of 2.5 feet. Each temporary monitoring point was advanced to the desired depth using a carbon steel rod with internal polypropylene tubing connected to the soil vapor probe. Soil around the steel rod was tamped to prevent short-circuiting of air between the probe tip and the ground surface. Care was also used not to purge large volumes of air through the probes so that ambient atmospheric air was not retrieved during soil gas monitoring procedures. The temporary soil gas monitoring probes were removed at the end of the one-year pilot test.

3.1.4 Blower Unit Installation and Operation

A 1-horsepower Gast R4110-2 regenerative blower unit was installed at Site FT-03 for the extended pilot test. The air permeability test was conducted using a portable 1-horsepower Rotron DR404 regenerative blower. The Gast blower was installed in a weatherproof enclosure and is energized by a 230-volt, single-phase, 30-amp circuit from a nearby above-ground, electrical utility pole and circuit breaker box provided by the base. Air is supplied by the blower through a 2-inch diameter above ground PVC header pipe that is attached to the vent well using a flexible PVC 4"x2" reducer.

The blower began operation for the extended bioventing test on November 23, 1992. Before starting the extended test, water was noted in the vent well as a result of four consecutive days of heavy rainfall the prior week. A water level was measured in the vent well and it was determined that the horizontal VW piping was submerged under approximately 11 inches of water. The elevated water table at the site was confirmed by placing a hand-augered boring on the north edge of the fire pit berm, where the water table stabilized in the open borehole at a depth of 2.2 feet bgs.

Rather than wait for the water levels to subside at the site, the extended bioventing test began by first starting the blower with the manual pressure relief valve fully open and then slowly closing the valve to begin blowing pressurized air into the vent well at an initial injection pressure of 42 inches of water and an air flow rate of approximately 45 standard cubic feet per minute (scfm). The initial high injection pressure was intended to remove the water from the vent well and surrounding formation so that effective air flow could be established in the unsaturated zone until the water levels

subsided. The air flow and injection pressures into the VW have since been reduced significantly by opening the manual pressure relief valve even further to bypass a large portion of the air to the atmosphere. The long-term operating air injection rate has varied from approximately 15 to 20 scfm at 12 to 26 inches of water pressure at the horizontal VW. Injection pressures vary based on soil moisture and water table influences on the horizontal well. Measurable soil pore pressures are being maintained at distances up to 30 feet under these operating conditions.

3.2 PILOT TEST PROCEDURES AND RESULTS

During installation of the VW and VMPs, soil samples were collected for laboratory analyses to establish baseline TRPH and BTEX concentrations and various inorganic and physical parameters. Results of these baseline soil analyses are summarized in Table 3.1 and Table 3.2. Soil gas samples were also collected for laboratory analyses from two VMPs to establish soil gas TVH and BTEX concentrations. The soil gas results are also summarized in Table 3.2.

Prior to initiating air injection, all VMPs were purged until oxygen levels had stabilized, and baseline oxygen, carbon dioxide, and then TVH concentrations were sampled using portable gas analyzers, as described in the technical protocol document (Hinchee et al., 1992). In contaminated soils, microorganisms had depleted soil gas oxygen concentrations to less than 1 percent. In contrast, the background VMP, outside the area of contamination, had 20.8 percent oxygen at a depth of 2.5 feet.

3.2.1 Baseline and Final Soil Hydrocarbon Concentrations

As described in previous investigations, soil hydrocarbon contamination at Site FT-03 appears to be confined mainly around the former burn pit within the bermed area. During the bioventing pilot test installations, contaminated soils were identified based on visual appearance, odor, and VOC field screening results. Heavily contaminated soils were encountered in the vent well trench and MPD borehole during initial system installation. Soils in these areas had strong hydrocarbon odors and were visibly stained from oily fuel contamination. Groundwater encountered during the trench excavation did not contain immiscible, floating fuel product.

During VW and VMP construction in November 1992, the greatest concentrations of soil contamination appeared to occur in the upper three feet of the soil profile. Soil samples for laboratory analysis were collected using a hand auger. Soil samples collected from the monitoring point borings were placed in air-tight plastic bags and screened for VOCs using a photoionization detector (PID). The PID headspace screening results were used to determine the relative contamination of each sample and as a guide for selecting samples for laboratory analyses. Soil samples for laboratory analysis were collected from MPA at a depth of 2.5 feet, from MPD at a depth of 3 feet, and from the VW trench at a depth of 3.5 feet. Each of the soil samples were analyzed for the following parameters: TRPH; individual BTEX compounds; iron; alkalinity; total Kjeldahl nitrogen (TKN); pH; phosphates; percent moisture; and grain size distribution. The results of these baseline analyses are presented in Table 3.1.

TABLE 3.1

INITIAL SOIL SAMPLE LABORATORY ANALYTICAL RESULTS
BIOVENTING PILOT TEST
SITE FT-03
CHARLESTON AFB, SOUTH CAROLINA

Analyte (Units)[a/]		Sample Location-Depth (feet below land surface)	
Soil Hydrocarbons	VW-3.5	MPA-2.5	MPD-3
TRPH (mg/kg)	1,100	51	2,200
Benzene (mg/kg)	<0.73[b/]	<0.72	<1.4
Toluene (mg/kg)	2.6	2.7	<1.1
Ethylbenzene (mg/kg)	1.6	<0.6	<1.6
Xylenes (mg/kg)	4.6	1.3	<2.1
Soil Inorganics	VW-3.5	MPA-2.5	MPD-3
Iron (mg/kg)	3,760	3,010	2,060
Alkalinity (mg/kg as $CaCO_3$)	650	<40	170
pH (units)	7.4	6.6	7.4
TKN (mg/kg)	180	520	360
Phosphates (mg/kg)	96	850	100
Soil Physical Parameters	VW-3.5	MPA-2.5	MPD-3
Moisture (% wt.)	17.9	16.8	12.6
Gravel (%)	0	6	0
Sand (%)	74	65.5	75
Silt (%)	19	21	20
Clay (%)	7	7.5	5

a/ TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram, ppmv = parts per million, volume per volume; $CaCo_3$ = calcium carbonate; TKN = total Kjeldahl nitrogen.

b/ Less than laboratory-reported method detection limit as shown.

TABLE 3.2
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
SITE FT-03
CHARLESTON AFB, SOUTH CAROLINA

Analyte (Units)[a]	Sample Location-Depth (feet below ground surface)					
	MPA-3.5		MPC-3.25		MPD-3.9	
Soil Gas Hydrocarbons	Initial[b]	1-Year[c]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	27	0.47	NS[d]	0.78	790	13
Benzene (ppmv)	<0.002	<0.002	NS	<0.002	<0.04	<0.002
Toluene (ppmv)	<0.002	<0.002	NS	<0.002	<0.04	<0.002
Ethylbenzene (ppmv)	<0.002	<0.002	NS	0.002	0.12	<0.002
Xylenes (ppmv)	0.002	<0.002	NS	<0.002	0.22	<0.002
	VW-3.5		MPA-2.5		MPD-3	
Soil Hydrocarbons	Initial[e]	1-Year[f]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	1,100	170	51	12	2,200	2,200
Benzene (mg/kg)	<0.73	<0.0027	<0.72	<0.0006	<1.4	<0.54
Toluene (mg/kg)	2.6	<0.0027	2.7	<0.0006	<1.1	<0.54
Ethylbenzene (mg/kg)	1.6	<0.0027	<0.6	<0.0006	<1.6	<0.54
Xylenes (mg/kg)	4.6	<0.0038	1.3	<0.0006	<2.1	<0.75
Moisture (%)	17.9	8.5	16.8	9.1	12.6	6.6

[a] TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram;
TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;
[b] Initial soil gas samples collected on May 6, 1993.
[c] Final soil gas samples collected on November 11, 1993.
[d] NS=not sampled.
[e] Initial soil samples collected on October 29, 1992.
[f] Final soil samples collected on November 11, 1993.

After completing one year of bioventing testing, confirmation soil samples were collected at the original sampling locations and analyzed for TRPH, BTEX and moisture. The purpose of the final sampling was to provide a qualitative indication of reduction in contaminant mass. A significant reduction of TRPH and BTEX compounds was observed in the soils after one year of bioventing. A comparison of the baseline and final soil sampling results from the one-year pilot test is provided in Table 3.2. These results also are summarized in the bioventing pilot test completion letter report (AFCEE, 1994) found in Appendix B.

3.2.2 Baseline and Final Soil Gas Hydrocarbons

Initial and final soil gas samples were collected for laboratory analyses of TVH and BTEX compounds during the bioventing pilot test. Due to elevated water table conditions (e.g. <2.5 feet bgs), baseline laboratory soil gas samples could not be collected from the permanent VMPs prior to the pilot test startup. As a result, initial soil gas samples were not collected for laboratory analyses until May 1993, when the water table had subsided and the blower was shut down for a respiration test after six months of operation.

After one-year of bioventing, final soil gas samples were collected for laboratory analyses for TVH and BTEX compounds. These results were compared to results of soil gas samples collected after six months of operation to provide a qualitative indication of reduction in soil gas hydrocarbon mass. A significant reduction of TVH and BTEX compounds was observed in soil gas after one year of bioventing. A comparison of initial and final soil gas sampling results is also provided in Table 3.2. Initial soil gas BTEX and TVH results shown in Table 3.2 were likely influenced by the six months of blower operation and therefore do not reflect the actual baseline (pretest) conditions. Baseline soil gas hydrocarbon concentrations were likely higher than the "initial" results shown in this table.

3.2.3 Air Permeability Test

An air permeability test was conducted according to bioventing protocol and work plan procedures. Air was injected into the VW at a rate of approximately 27.5 scfm and an average pressure of approximately 50 inches of water. Air injection continued for three hours until approximate steady-state pressure conditions were achieved. The HyperVentilate® model was used to determine soil permeability based on time versus pressure responses measured at various VMPs. Soil air permeability values ranging from 4 to 8 darcys were calculated for this site. These results are reasonable for a fine sandy soil matrix. The radius of soil pressure influence measured during the air permeability test was estimated to be between 30 and 40 feet.

3.2.4 Bioventing Oxygen Influence

The depth and radius of oxygen increase in the subsurface resulting from air injection into a VW during pilot testing is the primary design parameter for full-scale bioventing systems. Optimization of full-scale and multiple VW systems requires pilot testing to determine the volume of soil that can be oxygenated at a given flow rate and VW screen configuration. Oxygen concentrations in soil gas were measured at several

times during the pilot test to determine the short-term and long-term influences of air injection on soil gas oxygen concentrations.

3.2.4.1 Short-Term Oxygen Influence

Table 3.3 summarizes the change in soil gas oxygen levels that occurred during the air permeability test when air was injected at 27.5 scfm for a period of 3 hours. Oxygen level increases were measured at all VMPs except in MPD at a depth of 1.8 feet, where the oxygen level remained constant, and in MPC at a depth of 1.5 feet, where the oxygen level decreased during the test. Short-term oxygen reduction at MPC (1.5 feet) was likely due to oxygen-depleted soil gas being transported away from the VW during air injection. No final oxygen reading was taken from MPC at the 3.25-foot depth due to high water in this VMP during the air permeability test. These changes in oxygen levels indicate air movement through the soils at distances up to 20 feet during the short-term air permeability test.

3.2.4.2 Extended Bioventing Oxygen Influence

Soil gas oxygen, carbon dioxide, and TVH levels were measured periodically during the extended bioventing pilot test to determine the operating effectiveness of the system. Generally, soil gas measurements collected during extended testing are better indicators of the long-term influence of air injection on soil gas conditions. Soil gas oxygen distribution observed during extended air injection into a single VW is the best indicator of the radius of influence of the bioventing system. These results are useful in determining full-scale design criteria.

Table 3.4 shows the results of soil gas indicators that were field measured at various times during the extended bioventing pilot test. The November 1992 field data in Table 3.4 represent the pretest (i.e. baseline) soil gas conditions prior to air injection. Baseline soil gas conditions on that date showed oxygen-depleted soil gas in all of the deeper VMPs in the test area. Additionally, baseline soil gas concentrations of carbon dioxide and TVH were elevated in the VMPs at that time.

The May 1993 field data in Table 3.4 represent soil gas conditions after six months of air injection at flow rates of about 15 scfm to 18 scfm. Data in this table show good horizontal and vertical distribution of oxygen in subsurface soils at distances up to 20 feet from the VW. All of the deeper permanent VMPs that were measured had close to 20% oxygen in soil gas after six months of operation. Temporary monitoring point MPC (1.5-foot depth) located 20 feet from the VW had 17.5% oxygen. Temporary monitoring point MPF (1.5-foot depth) located 30 feet from the VW showed no detection (0%) of oxygen in soil gas. These results suggest a very distinct limit to the zones of shallow soil oxygenation that ended somewhere between 20 and 30 feet from the VW.

The June 1996 data in Table 3.4, representative of 3.5 years of air injection, is similar to the May 1993 soil gas data. Soil gas measured in permanent VMPs in June 1996 all showed greater than 20% oxygen in soil gas. Additionally, the results of the expanded soil gas survey conducted by Parsons ES (see Section 3.3) are presented in this table. These soil gas conditions also confirm that the long-term effective radius of oxygen influence is between 25 to 30 feet.

TABLE 3.3

INFLUENCE OF SHORT-TERM AIR INJECTION AT VENTING WELL ON MONITORING POINT OXYGEN LEVELS
SITE FT-03
CHARLESTON AFB, SOUTH CAROLINA

Air Permeability Test Results

MP	Distance From VW (ft)	Depth (ft)	Initial O_2 (%)	Final O_2 (%)[a/]
A	5	1.4	9.9	17.6
B	10	1.5	6.0	11.5
C	20	1.5	12.2	3.3
D	10	1.8	0.8	0.8
A	5	3.5	0.0	13.2
B	10	3.5	0.0	0.2
C	20	3.25	0.0	-- [b/]
D	10	3.9	0.0	13.7

a/ Reading taken at end of 3-hour air permeability test.
b/ No reading due to water in MP.

TABLE 3.4

SOIL GAS SCREENING INDICATORS
SITE FT-03
CHARLESTON AFB, SOUTH CAROLINA

November 1992: Baseline Conditions

Sample Location	Depth (ft)	Distance from VW (ft)	O_2 (%)	CO_2 (%)	TVH (ppmv)[a]	Temp (°F)
MPA	1.4	5	9.9	4.0	2,800	NS[b]
MPB	1.5	10	6	6.2	1,860	NS
MPC	1.5	20	12.2	4.3	110	NS
MPD	1.8	10	0.8	7.3	5,600	NS
MPA	3.5	5	0	8.2	5,000	63.8
MPB	3.5	10	0	7.8	1,400	NS
MPC	3.25	20	0	6.3	200	NS
MPD	3.9	10	0	8.4	>20,000	65.0
Background	2.5	90	18.7	0.2	94	NS

May 1993: 6 Months of Operation

Sample Location	Depth (ft)	Distance from VW (ft)	O_2 (%)	CO_2 (%)	TVH (ppmv)[a]	Temp (°F)
MPA	3.5	5	20.5	0.4	7	67.4
MPB	3.5	10	20.5	0.5	7	NS
MPC	1.5	20	17.5	3.5	34	NS
MPD	1.8	10	16.0	3.8	950	NS
MPD	3.9	10	19.7	0.9	130	66.8
MPF	1.5	30	0	13	72	NS

June 1996: 3.5 Years of Operation

Sample Location	Depth (ft)	Distance from VW (ft)	O_2 (%)	CO_2 (%)	TVH (ppmv)[a]	Temp (°F)
MPB	3.5	10	20.8	0.5	20	NS
MPC	3.25	20	20.7	0.7	26	NS
MPD	3.9	10	20.8	0.8	14	NS
SG96-1	3	17	19.8	1.6	26	NS
SG96-2	3	27	5.5	9.8	74	NS
SG96-3	3	51	0.5	11.8	320	NS
SG96-4	3	31	6.0	8.8	140	NS
SG96-5	3	25	20.0	0.6	12	NS
SG96-6	3	48	5.2	7.5	100	NS
SG96-7	3	69	0.9	10.0	1,000	NS
SG96-8	3	60	2.7	9.2	900	NS

a/ Hydrocarbon meter field screening results (Total Volatile Hydrocarbons).

b/ NS = not sampled.

Notes: 1) Blower was injecting air at rates of 15 to 18 scfm during May 1993 and June 1996 monitoring events.
2) See Figure 3.4 for locations of SG96-1 through SG96-8.

3.2.5 In-Situ Respiration Rates

In situ respiration testing was conducted to determine fuel biodegradation rates based on the oxygen utilization rates by indigenous bacteria in subsurface soils. Table 3.5 shows results of three *in situ* respiration testing events conducted as part of the bioventing pilot test. These testing events are listed as the initial, 6-month, and 12-month respiration tests.

The initial *in situ* respiration tests were conducted before turning on the air injection blower for pilot-scale operation. These initial tests were performed by injecting ambient air (21% oxygen) into the VMP screened intervals for a 12.5-hour period. Only two permanent monitoring points were useable for the initial tests due to the presence of water in the VMPs, which submerged the vapor probes. Small 1 scfm air pumps were used for air injection during the initial respiration tests. Changes in soil gas composition over time were measured after the air injection ceased. Oxygen, TVH, and carbon dioxide were measured for 30 hours following air injection. Air injection into the VW during the one-year pilot study oxygenated soils within the test area. As a result, the 6-month and 1-year respiration tests were performed by turning off the blower system and monitoring oxygen, carbon dioxide, and TVH levels in the VMPs.

The fuel biodegradation results determined by *in situ* respiration testing at this site are presented in Table 3.5 for the three testing events. Fuel biodegradation rates decreased slightly in most of the VMPs between the 6-month and 1-year respiration tests. Results from the respiration tests indicate that the hydrocarbon-contaminated soils have active microorganism populations and that biological respiration was still occurring in the soils after one year of air injection. The biodegradation rates presented in Table 3.5 are based on calculated air-filled porosities (liters of air per kilogram of soil) and a ratio of 3.5 milligrams of oxygen consumed for every 1 milligram of fuel biodegraded.

The background soil gas oxygen concentration for Site FT-03 was 18.7% as measured at a temporary soil gas monitoring point placed in shallow, uncontaminated soils. Air was also injected into this point to conduct a respiration test. There appeared to be little oxygen uptake due to abiotic reactions or non-fuel biodegradation. The percent oxygen measured at the background VMP remained essentially constant at 20 percent throughout the respiration test. Therefore, it can be assumed that oxygen uptake observed at this site is primarily the result of microbial biodegradation of fuel hydrocarbons.

3.3 EXTENDED SOIL GAS SURVEY

On June 12, 1996, Parsons ES conducted an additional soil gas survey at the site. The objectives of the survey were 1) to evaluate the long-term effectiveness of the existing vent well and blower system to oxygenate the soils, 2) to identify areas of the burn pit that still have oxygen-depleted soil gas and hydrocarbon contamination and 3) to assess the need and potential location for an additional vent well(s) at the site. Soil gas samples were collected while the existing VW was still operating. On the north side of the burn pit, soil gas samples and soil pressures were collected from three

TABLE 3.5
RESPIRATION AND FUEL BIODEGRADATION RATES
SITE FT-03
CHARLESTON AFB, SOUTH CAROLINA

Location-Depth (feet below ground surface)	Initial (November 1992)			6-Month (May 1993)			1-Year (November 1993)		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate[b/] (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA-3.5	NA[c/]	NA	NA	0.0046	270	19.7	0.00085	120	16.9
MPB-3.5	NA	NA	NA	0.0018	110	NS[d/]	0.00045	60	NS
MPC-3.25	NA	NA	NA	NS	NS	NS	0.00036	70	NS
MPD-1.8	NA	NA	NA	0.0031	370	NS	0.0028	510	NS
MPD-3.9	0.0088	580	19.0	0.014	1,690	19.3	0.0025	450	17.3

[a/] Milligrams hydrocarbons per kilogram soil per year.
[b/] Assumes moisture content of the soil is average of initial and final moistures.
[c/] NA=Not available; monitoring point was submerged during initial testing.
[d/] NS=Not sampled.

existing permanent VMPs (MPB-3.5, MPC-3.25, and MPD-3.9). On the south side of the burn pit, eight temporary soil gas probes were installed using a soil gas kit with retractable, screened sampling probes. Oxygen, carbon dioxide and TVH soil gas concentrations were measured at each point as indicators of bioventing progress. Results of the soil gas survey are listed under the June 1996 sampling event in Table 3.4. Figure 3.4 graphically depicts the soil gas results.

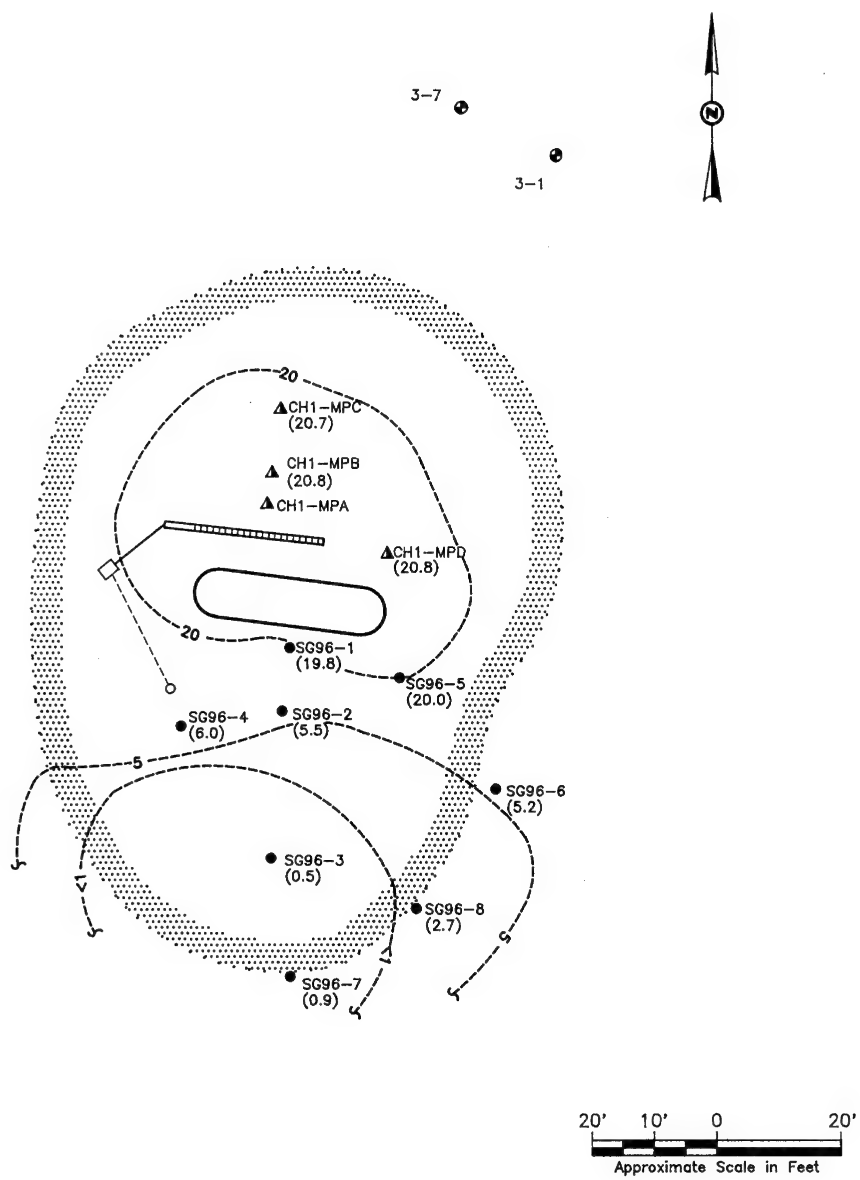
A comparison of the November 1992 data (baseline conditions) to the June 1996 data (3.5 years of operation) in Table 3.4 indicates the effectiveness of the existing bioventing system to reduce TVH concentrations in the soil gas, while aerating formerly oxygen-depleted soils. In monitoring point MPB-3.5, TVH soil gas concentrations were reduced from an initial level of 1,400 ppmv to 20 ppmv in June 1996. TVH concentrations in MPD-3.9 were reduced from >20,000 ppmv to 14 ppmv. Substantial TVH reductions were also observed in monitoring point MPC-3.25. Soil gas oxygen levels were initially 0% in monitoring points MPB-3.5, MPC-3.25, and MPD-3.9. These oxygen concentrations had increased to greater than 20% during June 1996.

Eight additional temporary soil gas monitoring points (SG96-1 through SG96-8) were installed on the south of the burn pit and the existing vent well. Figure 3.4 shows the locations of the temporary soil gas points and the soil gas results, including the approximate distribution of soil gas oxygen content at the 3-foot depth. Elevated TVH concentrations were observed at points SG96-3, SG96-4, SG96-7, and SG96-8, suggesting that fuel hydrocarbons still exist in the subsurface on the south side of the burn pit. Soil contamination in this area likely results from the former fire training exercises in the burn pit and possible movement of fuel-contaminated groundwater toward the south. Soil gas oxygen and carbon dioxide concentrations were also measured at the temporary soil gas monitoring points. Reduced soil gas oxygen levels in subsurface soils were observed in soil gas points SG96-3 (0.5%), SG96-4 (6.0%), SG96-6(5.2%), SG96-7 (0.9%), and SG96-8 (2.7%). Elevated carbon dioxide levels were also observed at most of these locations, indicative of microbial respiration (see Table 3.4).

These data indicate that the existing bioventing system is oxygenating subsurface soils within an approximate 25-foot to 30-foot radius of the horizontal VW. There was a distinct reduction of soil gas oxygen concentrations from SG96-1 (19.8% oxygen), at a radius of 17 feet from the VW, compared to results from SG96-2 (5.5 % oxygen) at a radius of 27 feet from the VW. As indicated by the oxygen isoconcentration contours shown in Figure 3.4, there is a significant area of oxygen-depleted soils on the south end of the burn pit that is not being affected by air injection from the existing bioventing system.

Previous respiration testing demonstrated that aerobic biodegradation of fuel hydrocarbons can be stimulated under these oxygen-enhanced conditions. It appears that residual soil contamination still exists within the site, especially on the south end of the burn pit. Additional sampling will be required to determine the actual distribution and concentrations of hydrocarbons that are currently present in soil.

Figure 3.4



June 1996 Soil Gas Sampling Results				
Sample Location	Depth (ft)	O_2 (%)	CO_2 (%)	TVH (ppmv)
MPB	3.5	20.8	0.5	20
MPC	3.25	20.7	0.7	26
MPD	3.9	20.8	0.8	14
SG96-1	3	19.8	1.6	26
SG96-2	3	5.5	9.8	74
SG96-3	3	0.5	11.8	320
SG96-4	3	6.0	8.8	140
SG96-5	3	20.0	0.6	12
SG96-6	3	5.2	7.5	100
SG96-7	3	0.9	10.0	1,000
SG96-8	3	2.7	9.2	900

LEGEND

- CH1-MPA ▲ Permanent soil vapor/pressure monitoring point.
- 3-7 Groundwater monitoring well.
- SG96-1 ● Temporary soil gas monitoring location (1996 survey).
- (5.5) Soil gas oxygen content (%).
- 5 Soil oxygen isoconcentration (%).
- Approximate boundary of burn pit soil berm.

NOTES:

1.) Soil berm has approximate elliptical dimensions and varying widths. Locations of tank, vent well, and utility pole within berm are estimated.

2.) The blower was injecting air into the horizontal vent well during the soil gas survey. Soil gas results reflect long-term operating conditions.

3.) Total volatile hydrocarbons (TVH) measured with field hydrocarbon meter.

Soil Gas Survey Locations and Results: June 12, 1996

Site FT-03
Fire Training Area No. 3
Charleston AFB, South Carolina

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3.4 POTENTIAL AIR EMISSIONS

Emissions of fugitive vapors from the soil to the atmosphere are not an operating concern for the proposed system. Ambient air was monitored in the breathing zone during the pilot system startup and no hydrocarbons were detected at sustained concentrations above 5 ppmv. Subsequent air monitoring later in the pilot test showed no detection of hydrocarbon vapors in atmospheric air around the test zone.

During the November 1992 pilot test soil sampling event, Parsons ES determined that soil BTEX concentrations initially ranged from below detection limits to 8.8 mg/kg. No benzene was detected in the soil or soil gas analyses (Table 3.2). The average operating air injection flow rate for the pilot-scale bioventing system is low, ranging from approximately 15 to 20 scfm. Monitoring data suggest that the TVH soil gas concentrations have decreased due to the air injection and biodegradation processes. Minor losses of soil vapors to the atmosphere was expected during startup of the pilot test system due to the shallow nature of the site contaminants. Similar conditions should be expected during startup of the expanded system. However, the low air injection rates, combined with minimal BTEX concentrations detected in site soils and soil gas, should minimize fugitive emissions that potentially may occur during startup.

3.5 RECOMMENDATION FOR FULL-SCALE BIOVENTING

Based on the positive results of the one-year bioventing pilot test and continued operation of that system for an additional 2.5 years, AFCEE has provided funding for the design and installation of an expanded bioventing system that will remediate the remaining fuel-contaminated soils at Site FT-03. AFCEE has retained Parsons ES to continue bioventing services at Charleston AFB and to complete the design and installation of an expanded bioventing system. Based on the initial pilot test results, available analytical data, and recently completed soil gas sampling, Parsons ES has prepared a conceptual full-scale upgrade design that will employ the existing horizontal VW and an additional horizontal VW located on the south side of the burn pit. Six additional VMPs also will be installed to ensure oxygen is being delivered to contaminated soils. In addition, five more soil samples will be collected to further define the extent of contamination. If field screening determines that significant soil contamination is present in these boreholes, additional VMPs may be required. Section 4 provides details on the design, construction, and operation of the expanded system. A design package has been prepared for construction of the system and is included in Appendix A of this Interim Measures Work Plan.

SECTION 4

EXPANDED BIOVENTING SYSTEM

The purpose of the expanded bioventing system is to provide oxygen to stimulate aerobic biodegradation of the remaining hydrocarbon contaminants present in soil at Site FT-03. Operation of the existing VW and an additional air injection VW will provide atmospheric air (oxygen) to oxygen-depleted, contaminated soils at the site. The full extent of soil contamination has not been defined; therefore, six additional soil borings will be installed and converted to VMPs. If significant soil contamination is observed in all six boreholes, additional VMPs may be installed and the new VW may be expanded in size to treat the larger area of soil contamination. Previous site investigations suggest that the majority of residual subsurface soil contaminants are found in close proximity to the burn pit.

A common blower will be used to provide air to both the existing and proposed horizontal VWs. The existing blower has operated almost continuously for more than three years and its remaining service life is questionable. As a result, a new air injection blower, blower enclosure and electrical wiring will be installed at the site.

The burn pit is surrounded by an earthen berm that collects rain water due to poor surface drainage. As a result, Parsons ES proposes to construct a soil cap with clean backfill soil over the proposed VW trench and surrounding areas to promote drainage away from new VW and the burn pit. Additionally, one or more drainage pathways will be made in the soil berm to promote surface drainage from the burn pit. A small drainage pathway currently passes through the east side of the soil berm. This existing drainage pathway does not adequately drain the burn pit and it may be excavated lower than its current elevation to facilitate surface drainage. There are no known underground utilities at the site. An existing overhead electrical service was installed during 1992 to provide electrical power to the blower. Currently, an aboveground electrical conduit connects the electrical disconnect on the pole to the blower. System design details are provided in Appendix A.

4.1 OBJECTIVES

Following its installation, the primary objectives for operating the expanded bioventing system will be to:

- Optimize the system to fully aerate unsaturated, subsurface soils in areas of the site designated for bioventing remediation;
- Reduce the existing hydrocarbon contaminant levels to below acceptable regulatory cleanup levels, ARARs or other cleanup criteria established for the site. In the absence of established regulatory cleanup goals for specific contaminants, such as TRPH, reduce the concentrations to levels that will gain regulatory approval for no further action;

- Eliminate the potential for continued hydrocarbon partitioning to groundwater, particularly the BTEX compounds, by removing the contaminant source from vadose zone soils; and
- Provide the most cost-effective soil remediation alternative for the site.

As stated earlier in this report, soil TRPH concentrations will be monitored during the bioventing remediation activities, even though there are no established TRPH soil cleanup criteria for this site. There are, however, established ARAR/TBC levels established for individual BTEX compounds and other VOCs, which will also be monitored in the soils. Two of the VOCs (benzene and 1,2-dichloroethane) exceeded the ARAR/TBC levels for groundwater. Reduction of organic compounds in the soils using the bioventing technology is expected to benefit groundwater remediation by removing the primary contaminant source.

4.2 BASIS OF DESIGN

Site investigation data, pilot test data, and experience at similar bioventing sites provide the basis of this bioventing design. The expanded bioventing system was designed to provide oxygen to areas having significant soil contamination. Shallow vadose zone soils and deeper soils in the hydrocarbon smear zone have been targeted for remediation. The extent and magnitude of soil contamination will be better defined in the burn pit area as part of this project. Therefore, the design includes installation of six or more additional soil borings and collection of five additional soil samples to further investigate soil contamination. If significant vadose zone contamination is encountered during field screening of soils from the borings, then the proposed horizontal VW trench may be modified to better affect other areas of the site. If significant vadose zone contamination is not encountered in a soil boring, either a VMP will be installed or the boring will be abandoned. A minimum of six additional VMPs are proposed for this site.

Pilot test data such as operating pressures, air injection flow rates and radius of oxygen influence were considered during design development. These data were considered in the placement of the VW and sizing of a full-scale blower system. In addition to the pilot test data from this site, experience at other sites with similar site conditions and soils was considered in design development. The significant design parameters and considerations are as follow:

- A radius of oxygen influence of 30 feet was used, resulting in placement of the new horizontal VW near the center of the burn area, perpendicular to the existing VW located on the north side of the burn pit. This area appears to be within the area of greatest vadose zone contamination (see Section 3.3).
- An air injection pressure capability up to 45 inches of water was assumed in sizing the full-scale bioventing blower, with long-term operating pressures in the range of 10 to 20 inches of water pressure during dry soil conditions. This is consistent with varying pressures observed during the extended pilot test when the water table is both elevated and low at the site.

- A combined air injection flow rate of between 40 to 60 scfm for both VWs was assumed based on experience at this and other sites.

The full-scale design will utilize a new blower in a pre-fabricated enclosure to provide air to the existing and proposed VWs. The proposed locations of the six additional VMPs were based on the following design criteria:

- to provide additional information on the extent of shallow soil hydrocarbon contamination,
- to evaluate the magnitude of contaminant reduction through soil gas sampling, and
- to provide important oxygen influence data.

The six proposed VMPs would be located within the anticipated radius of influence for the combined VW system to monitor system effectiveness throughout the project duration.

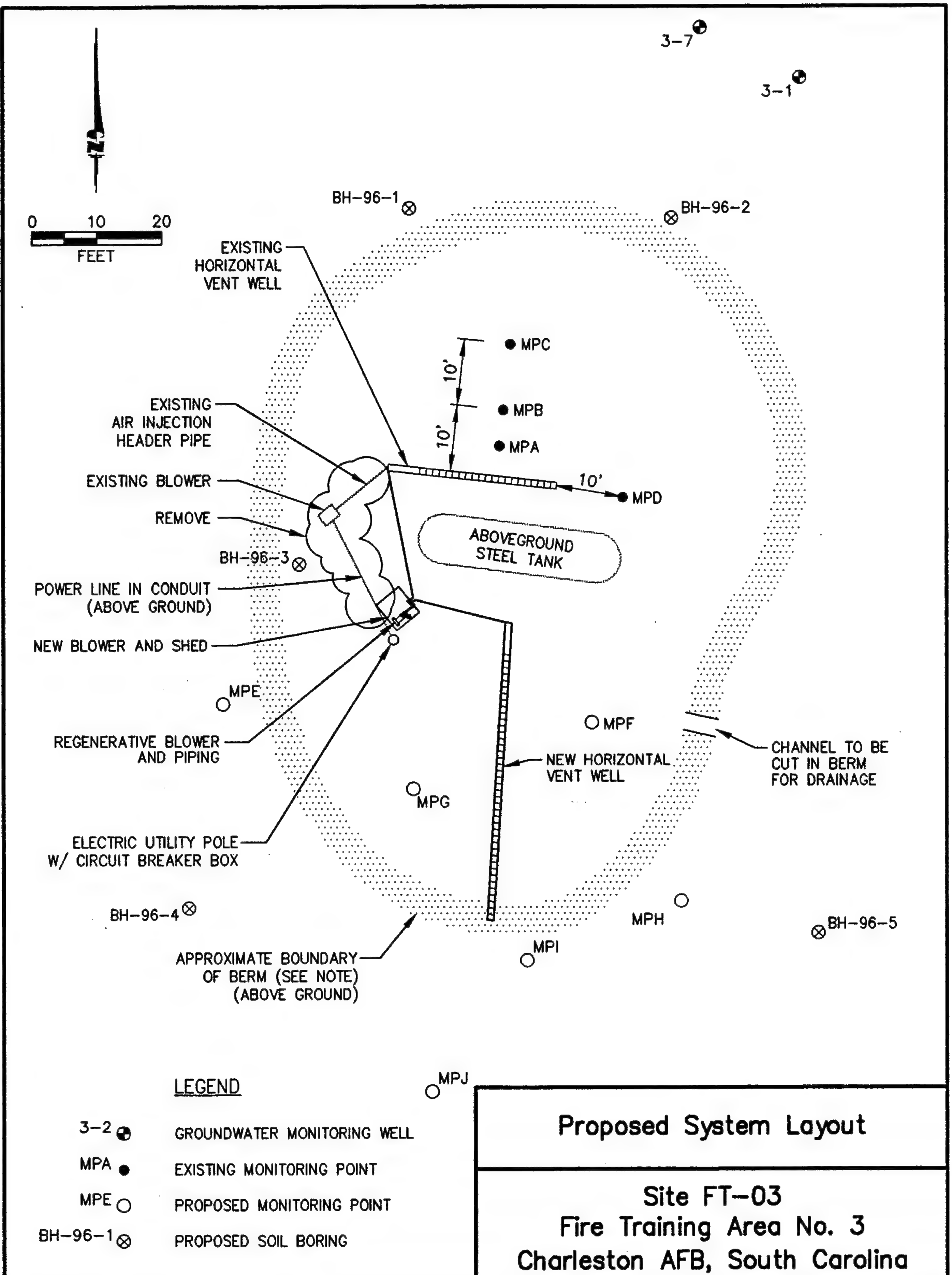
4.3 SYSTEM DESIGN AND CONSTRUCTION

The proposed expanded bioventing system at Site FT-03 will incorporate a new regenerative blower, blower enclosure and horizontal VW. Also, a minimum of six new VMPs will be constructed to monitor soil gas conditions and to ensure adequate oxygen influence throughout the area of soil contamination. The new VW trench will be excavated with a backhoe approximately 45 feet long and 3.5 feet deep. The new VW will be constructed with 4-inch diameter PVC screens and casings. The screened interval will consist of 40 feet of 0.020-inch slot recovery well screen surrounded by a coarse silica sand gravel pack. Excavated soil will be backfilled into the trench and compacted in place by tamping for bioventing treatment. Figure 4.1 shows the locations of the existing and proposed new VWs and VMPs. Trench configuration and other design details are included in the design package provided in Appendix A.

The existing VW and proposed VW will be manifolded using 2-inch-diameter, schedule 40 PVC as the conduit for the injected air to flow from the blower to the VWs. The piping will be connected to a new 1.5 HP regenerative blower and will be set at a depth of 18 inches beneath the ground surface. A separate (manual) flow control valve and flow measurement port will be included in the air injection piping connected to each VW to allow adjustment of the air flow to each VW. The blower and valving will be housed in a weatherproof enclosure for protection from the elements and for security purposes.

Based on bioventing monitoring results at this site, a maximum injection rate of 40 scfm at the new VW should be sufficient to supply oxygen to the remaining contaminated soils and sustain *in situ* fuel biodegradation. The existing pilot test VW will likely continue operating as part of the full-scale system at an air injection rate of 15 scfm or less. The effective radius of oxygen influence around the existing VW was estimated to be between 25 to 30 feet using an air injection rate of approximately 1 scfm per foot of vent well screen. Similar air flow results are expected for the proposed new VW. The proposed VW location was selected to provide oxygenation of

FIGURE 4.1



Proposed System Layout

Site FT-03
Fire Training Area No. 3
Charleston AFB, South Carolina

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PARSONS ENGINEERING SCIENCE, INC.

contaminated, oxygen-depleted soils identified during the soil gas survey and during previous site investigations.

Additional soil borings will be advanced to further define the extent of soil contamination at this site. Figure 4.1 shows the proposed locations of these borings. If field screening during installation of the soil borings shows significant vadose zone contamination outside of the burn pit, then the proposed VW will be extended further south and additional VMPs will be installed in this area. Two soil borings also will be advanced north of the burn pit to confirm the absence of soil contamination upgradient of the pit.

4.4 PROJECT SCHEDULE

The following schedule for the bioventing system upgrade is contingent upon approval of the Work Permit Request.

Event	Start Date	End Date	Duration (working days)
Submit Draft Work Plan and Design Package to AFCEE/ERT and Charleston AFB	NA	12 July 1996	NA
Charleston AFB/AFCEE Review Period	15 July 1996	27 Sept. 1996	55 days
Respond to Comments on Draft	30 Sept. 1996	1 Nov. 1996	25 days
Submit Draft Final Plan to AFCEE/ERT, Charleston AFB, USEPA[a/], and SCDHEC [a/]	NA	4 Nov. 1996	NA
Draft Final Work Plan Review Period	5 Nov. 1996	4 March 1997	78 days
Respond to comments on Draft Final Plan	5 March 1997	4 April 1997	22 days
Final Interim Measures Work Plan and Design Package to AFCEE/ERT, Charleston AFB, and SCDHEC	NA	7 April 1997	NA
Submit Work Permit (digging permit) Request	NA	7 April 1997	NA
Construction of Expanded System/System Startup	21 April 1997	2 May 1997	10 days
Complete Construction Drawings/O&M Manual	5 May 1997	13 June 1997	30 days

[a/]Draft Final copies for USEPA and SCDHEC submitted by Charleston AFB.

year of maintenance support under Option 1 of the Extended Bioventing Project. Should the blower system give indications of an electrical or mechanical problem, such as a significant change in outlet pressure, abnormal noises from the blower, or system failure, during the first year of operation, Parsons ES will be responsible for repairing the system. Prior to mobilizing to the site, Parsons ES may request that a base electrician verify that adequate power is still being supplied to the blower motor. Once adequate power to the motor has been verified, Parsons ES will take the necessary actions to repair the blower system. Following the year of O&M support by Parsons ES, Charleston AFB will be responsible for system maintenance.

4.5.3 System Performance Monitoring

Routine monitoring of the bioventing system will include system checks of blower operation, including outlet pressures, inlet vacuum, and exhaust temperature every two weeks. These system checks will be performed by Charleston AFB personnel during and after the first year of operation.

To provide baseline data against which the progress of remediation can be evaluated, additional soil and soil gas samples will be collected during installation of the full-scale bioventing system. These data and the data collected during the pilot test project, the previous RFI studies, and the June 1996 soil gas survey will be used as a basis for evaluating effectiveness of the full-scale bioventing system.

Soil samples will be collected from all boreholes advanced during installation of the VMPs. Samples will be collected at 1-foot intervals, and will be screened in the field for organic vapors using a PID. Using the PID screening results as a guide to determine relative contamination, five soil samples will be sent to a South Carolina certified analytical laboratory for analysis of BTEX by Method SW8020, TRPH by Method SW8015 (modified), chlorinated hydrocarbons by Method SW8010, semi-volatile and polynuclear aromatic hydrocarbons (PAH) by Method SW8270, and eight RCRA metals by Method SW6010. Five soil samples will be collected from different boreholes for laboratory analyses if field screening indicates significant contamination is present at these locations.

Soil gas screening will be conducted with field instruments at all VMPs and VWs prior to system startup to establish baseline oxygen, carbon dioxide, and TVH levels. In addition, soil gas samples will be collected from five VMPs and will be forwarded to Air Toxics Ltd. of Folsom, California for analysis of TVH and BTEX by Method TO-3. The locations of these samples will be determined based on the field screening results. The five VMPs exhibiting the highest soil gas TVH concentrations (measured with field instruments) will be sampled for laboratory analysis.

System performance monitoring by Parsons ES under Option 1 of the Extended Bioventing Project will include *in situ* respiration testing during a site visit after one year of full-scale system operation. Soil gas samples will also be collected from the same five VMPs sampled during full-scale system installation and reanalyzed for BTEX and TVH using Method TO-3. No soil sampling will be performed under Option 1 of the Extended Bioventing Project. An Option 2 has been funded for this site that includes final confirmation soil sampling. The Option 2 closure soil sampling will be

initiated for this site when sampling indicators (i.e. soil gas and respiration data) indicate that significant reduction of hydrocarbons, especially the BTEX compounds, has occurred.

Prior to performing the 1-year respiration tests and soil gas sampling, the blowers will be turned off for 30 days to allow soil gas to equilibrate so that 1-year data can be compared to initial soil gas data. Air will be injected into VWs or VMPs for approximately 20 hours, and then shut off. Oxygen uptake will be monitored in the VMPs for approximately 72 hours to measure the rate at which oxygen decreases in the soil gas. These data will then be used to estimate the current biodegradation rates and to evaluate the progress of contaminant removal and system effectiveness. As the fuel in the soil is depleted, the respiration activity of the indigenous microorganisms is reduced, and slower oxygen utilization rates result. The use of oxygen utilization and soil gas chemistry as indicators of remaining contaminant concentration decreases the likelihood of premature closure soil sampling events.

System monitoring and *in situ* respiration test data will be analyzed to determine the progress of soil remediation. Estimates of contaminant reduction and time remaining to complete soil remediation will be based on the data collected during the respiration tests (oxygen utilization rates), quantitative estimates of the long-term biodegradation rates, and decreases in soil gas concentrations. If soil gas data indicate that the soils have been sufficiently remediated, closure soil sampling will be initiated under an Option 2.

Charleston AFB will be responsible for monitoring the bioventing system after the initial year of full-scale system operation is completed and prior to obtaining regulatory approval of a closure soil sampling and analysis plan (Option 2). It is recommended that annual respiration testing and soil gas sampling be performed to evaluate the progress of remediation until the closure sampling plan is approved and executed. Assuming that these monitoring activities are performed by a contractor, the annual cost to perform these activities is estimated as $15,500. In addition to these activities, monitoring the system pressure, vacuum, and temperature should be performed every two weeks.

SECTION 5

HANDLING OF INVESTIGATION-DERIVED WASTES

Soil generated during excavation of the VW trench will be placed back into the trench for bioventing treatment to the extent practical. Any excess soil from this excavation will be containerized in 55-gallon drums and transported to a staging area designated by Charleston AFB. All soil cuttings generated during VMP soil boring installations will be containerized in 55-gallon drums and transported to the same staging area. Each drum will be clearly labeled as to its contents, site name, location, and date of generation. The volume of waste soil generated by these processes is expected to be minimal and will probably be less than four drums.

Waste disposal will be coordinated with the base according to base waste-handling procedures. Because this site is listed as a RCRA Solid Waste Management Unit, a comprehensive list of analyses may be required for acceptance at an appropriate waste disposal facility. It is anticipated that results of the laboratory analyses from the five environmental soil samples will adequately represent contaminant concentrations in the waste soils. Additionally, previous analytical data generated during the RFI can be used to further characterize soil contaminants that are expected to be present in wastes generated at this site. Additional waste characterization of drum composite samples will be performed if SCDHEC determines that the results of environmental samples are not acceptable to characterize the waste soils for disposal.

Decontamination of the backhoe bucket, augers, sampling equipment and other items requiring decontamination will be performed at a temporary decontamination area set up at the site. Decontamination water will be placed in a 55-gallon drum and then transported to an approved staging area. As with the waste soils, analyses of a composite sample will be performed if required by SCDHEC for off-base disposal. The volume of liquid wastes from decontamination is expected to be less than 30 gallons since there is minimal equipment that will be in contact with contaminated soils.

SECTION 6

BASE SUPPORT REQUIREMENTS

The following support from Charleston AFB is needed prior to arrival of the Parsons ES team and subcontractor(s) at the base:

- Assistance in obtaining a base digging permit.
- Obtaining all necessary regulatory permits and approvals for installation of the VWs, VMPs, and to conduct soil borings and sampling
- Assistance in obtaining an extension or amendment to the Underground Air Injection Control Permit from SCDHEC to allow construction and operation of the proposed new VW.
- Provide any paperwork required to obtain gate passes and security badges for subcontractor personnel and two Parsons ES employees. If required by the base, vehicle passes will be needed for two Parsons ES trucks and several subcontractor support trucks. These passes must be valid for the expected duration of VW installation (about 1 week) and the full-scale system installation and startup (about 3 weeks).
- A municipal water supply for well construction and decontamination activities.

During full-scale bioventing, base personnel will be required to check the blower systems once every two weeks to ensure that they are operating properly, record air injection pressures and temperatures, and replace air filters as needed. Parsons ES will provide a maintenance procedures manual and a brief training session.

1. If a blower stops working, notify Mr. Grant Watkins of Parsons ES - Cary at (919) 677-0080, Mr. John Ratz of Parsons ES - Denver at (303) 831-8100, or Capt. Ed Marchand of AFCEE at (210) 536-4364.
2. Arrange site access for a Parsons ES technician to conduct respiration testing and soil gas sampling approximately one year after full-scale system installation and start up.

SECTION 7

POINTS OF CONTACT

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Cary, NC 27513
(919) 677-0080
Fax: (919) 677-0118

SECTION 8

REFERENCES

AFCEE 1994. Completion Of One-Year Bioventing Test, Fire Training Area, FT-03. Letter results report memo to Charleston AFB 437 SPTG/CEV dated 27 June 1994.

Engineering-Science, Inc. 1993. *Part I, Bioventing Pilot Test Work Plan and Part II, Draft Interim Bioventing Pilot Test Results Report for Fire Protection Training Area Site FT-03, Charleston AFB, South Carolina.* January.

Halliburton NUS. 1995. *Draft RCRA Facility Investigation Report for Charleston AFB, South Carolina.* June.

Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frandt. 1992. *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing.* January.

Versar, Inc. 1992. *Installation Restoration Program, Phase II Remedial Investigation/Feasibility Study Report, Stage 2, Charleston AFB, South Carolina.* April.

APPENDIX A
DESIGN PACKAGE

CONSTRUCTION DRAWINGS FOR

EXPANDED BIOVENTING SYSTEM
SITE FT-03
CHARLESTON AIR FORCE BASE

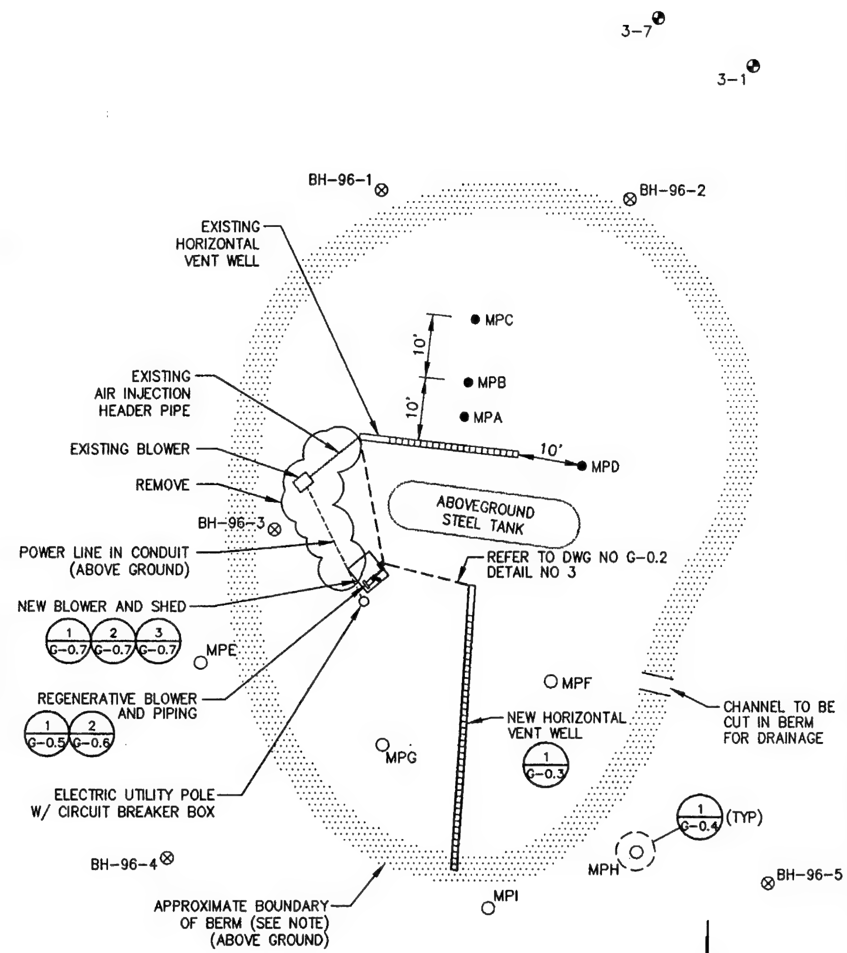
PREPARED FOR

AFCEE

JULY 1996

DRAWING INDEX

DRAWING NO	DRAWING NAME
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAILS
G-0.3	VENT WELL STANDARD DETAIL
G-0.4	MONITORING POINT STANDARD DETAIL
G-0.5	BLOWER P & ID
G-0.6	BLOWER PIPING LAYOUT DETAIL
G-0.7	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAIL



NOTE:
SOIL BERM HAS APPROXIMATE ELLIPTICAL DIMENSIONS AND VARYING WIDTHS, LOCATIONS OF TANK, VENT WELL AND UTILITY POLE WITHIN BERM ARE ESTIMATED.

SITE LAYOUT

SCALE: 1" = 20'

Job No. 726876.28140				
Designed RAF				
Drawn MW				
Checked RAF	7/11/96			
Reviewed PBA	7/11/96			
Approved JVR	7/11/96			
Reg No	A	7/11/96	85% DESIGN	
Date	Rev	Date	Description	By

PARSONS ENGINEERING SCIENCE, INC
Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
EXPANDED BIOVENTING SYSTEM
SITE FT-03
CHARLESTON AIR FORCE BASE

TITLE SHEET AND SITE LAYOUT

DRAWING NO **G-0.1** REV **A**

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ABBREVIATIONS

AIJ	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
&	AND
@	AT
CBM	CENTER BACK MOUNT
CLR	CLEAR
DIA	DIAMETER
DWG	DRAWING
EB	EXPLORATORY BORING
ECC	ECCENTRIC
EW	EACH WAY
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FT	FOOT
GALV	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHYLENE
ie	FOR EXAMPLE
LM	LOWER MOUNT
MAX	MAXIMUM
MIL	MILLIMETER
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO, #	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
PW	PROPOSED WELL
RED	REDUCER
REF	REFERENCE
SCH	SCHEDULE
S	SOCKET
SPVC	SLOTTED POLYVINYL CHLORIDE
ST STL	STAINLESS STEEL
TYP	TYPICAL
UST	UNDERGROUND STORAGE TANK
VW	VENT WELL
W/	WITH
WN	WELD NECK
WWF	WELDED WIRE FABRIC

SYMBOLS

MPC●	EXISTING BIOVENTING MONITORING POINT
MPE○	PROPOSED BIOVENTING MONITORING POINT
BH-96-1⊗	PROPOSED SOIL BORING
3-7	GROUNDWATER MONITORING WELL
	BERM
----	PROPOSED HEADER PIPE TO VENT WELL

SECTION DESIGNATION — (A / X) — SECTION NAME — **SECTION CUT** — SCALE: NTS — SCALE — DRAWING OF ORIGIN

DETAIL NO — (1 / X) — DETAIL NAME — **DETAIL DESCRIPTION** — SCALE: NTS — SCALE — DRAWING OF ORIGIN

MATERIAL LEGEND

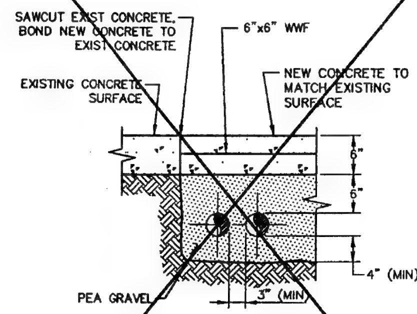
- ASPHALT
- BENTONITE
- BENTONITE/CEMENT GROUT
- BENTONITE PELLETS
- BUILDING (EXISTING)
- COMPACTED BACKFILL
- COMPACTED BASE STONE
- CONCRETE
- PEA GRAVEL
- SAND
- UNDISTURBED SOIL

PIPE MATERIAL

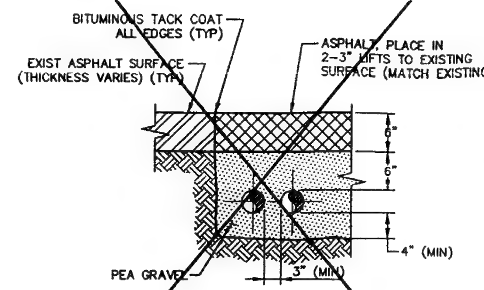
CS	CARBON STEEL
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

PIPE SERVICE

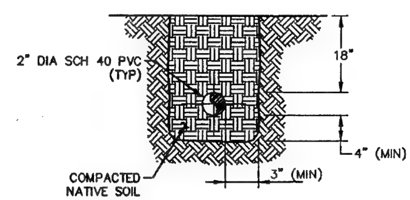
AIJ	AIR INJECTION
BIV	BIOVENTING
DR	DRAIN



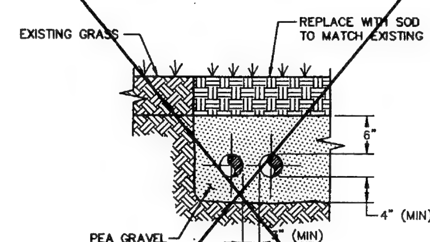
1 — CONCRETE REPLACEMENT DETAIL
SCALE: NTS



2 — ASPHALT REPLACEMENT DETAIL
SCALE: NTS



3 — SOIL COVER REPLACEMENT DETAIL
SCALE: NTS



4 — GRASS COVER REPLACEMENT DETAIL
SCALE: NTS

Job No. 726876.28140	Rev	Date	Description	By
Designed RAF				
Drawn MW				
Checked		7/10/96		
Reviewed		7/11/96		
Approved		7/11/96		
Reg No	A	7/11/96	85% DESIGN	
Date				

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Denver, Colorado (303) 831-8100

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
EXPANDED BIOVENTING SYSTEM
SITE FT-03
CHARLESTON AIR FORCE BASE

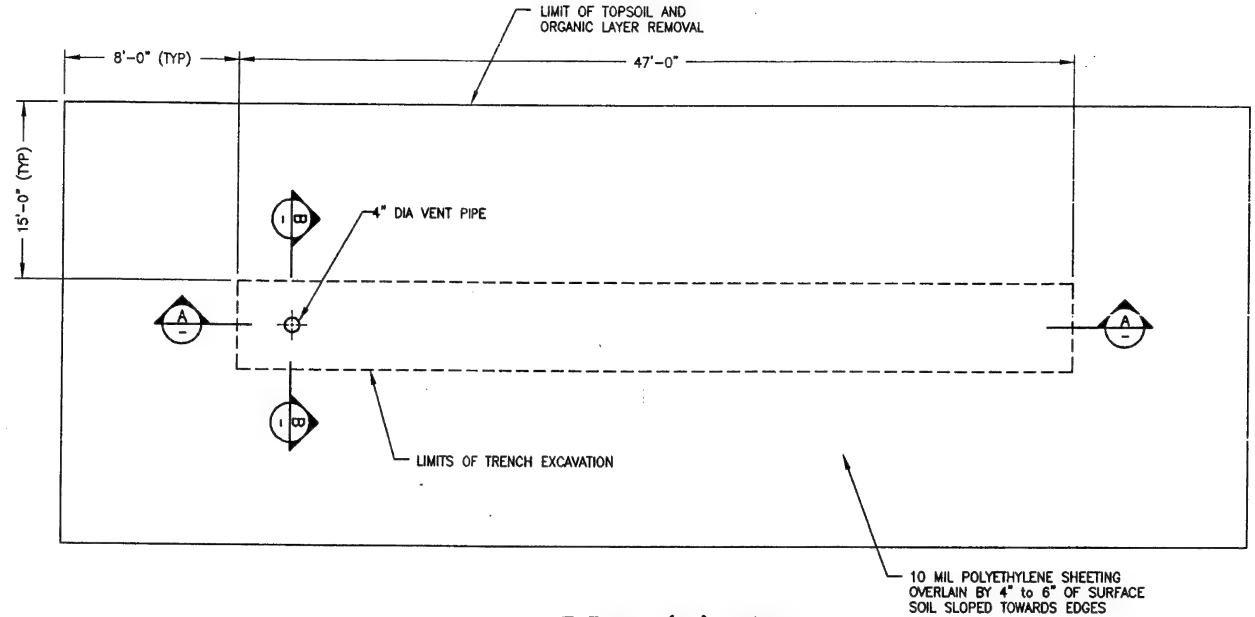
LEGEND AND STANDARD TRENCH DETAILS

DRAWING NO G-0.2 — REV A

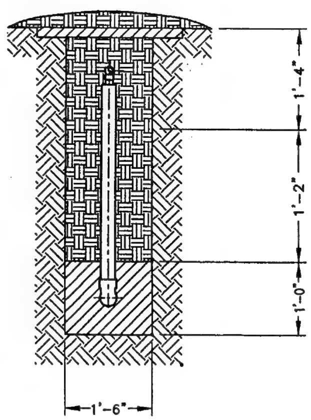
K:\AFCEE\726876\CHRLSTON\96DN0504, 07/11/96 at 10:39

NOTES:

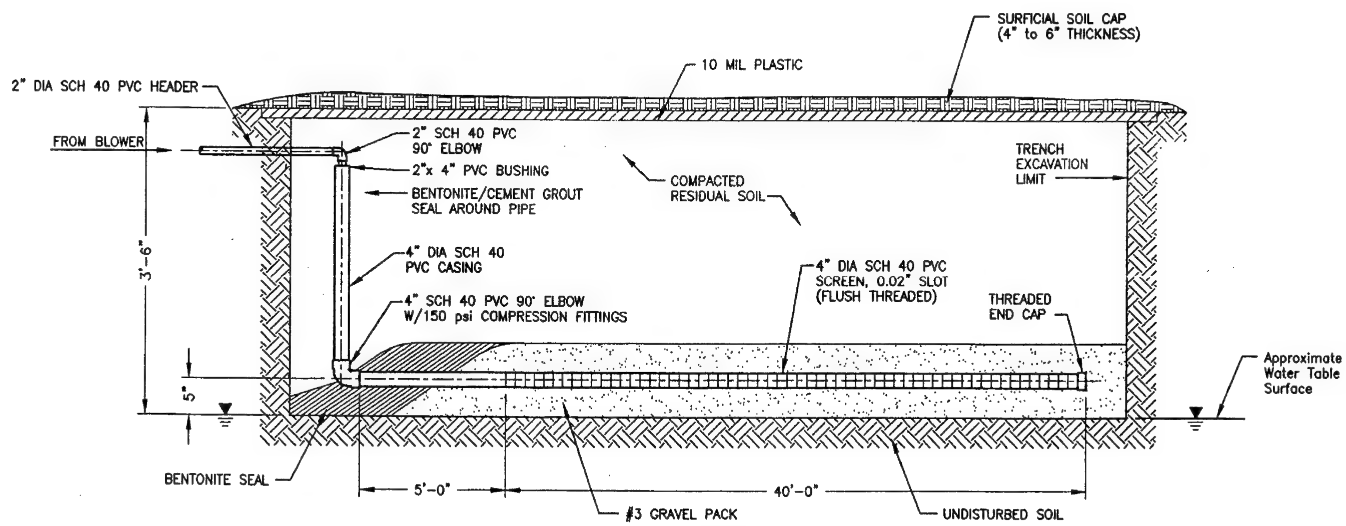
1. DRAWING IS NOT TO SCALE.
2. POLYETHYLENE SHEETING SHALL BE OVERLAPPED BY 5 FEET WHERE REQUIRED.



1 VENT WELL (VW) DETAIL



B SECTION



A SECTION

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FT-03
CHARLESTON AIR FORCE BASE

PARSONS ENGINEERING SCIENCE, INC.
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VENT WELL
STANDARD DETAIL

DRAWING NO G-0.3 | REV A

Job No.	726876.28140
Designed	RAF
Drawn	MW
Checked	RAF 7/11/96
Reviewed	7/11/96
Approved	7/11/96
Reg No	
Date	

Rev	Date	Description	By
A	7/11/96	65% DESIGN	

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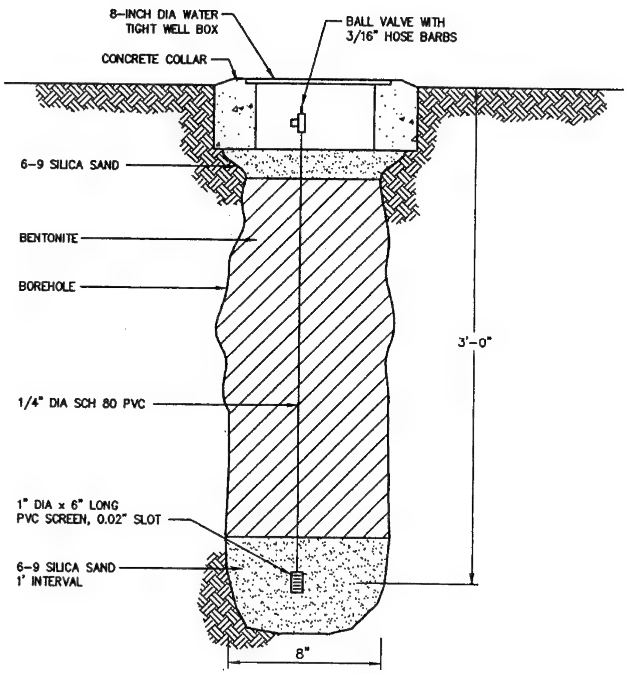

1 — MONITORING POINT (MP) DETAIL

SCALE: NTS

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Job No. 726876.28140				
Designed RAF				
Drawn WW				
Checked RAF	7/11/96			
Reviewed PBK	7/11/96			
Approved JCR	7/11/96			
Reg No		1	7/11/96	RECORD DRAWING
Date		Rev	Date	Description	By

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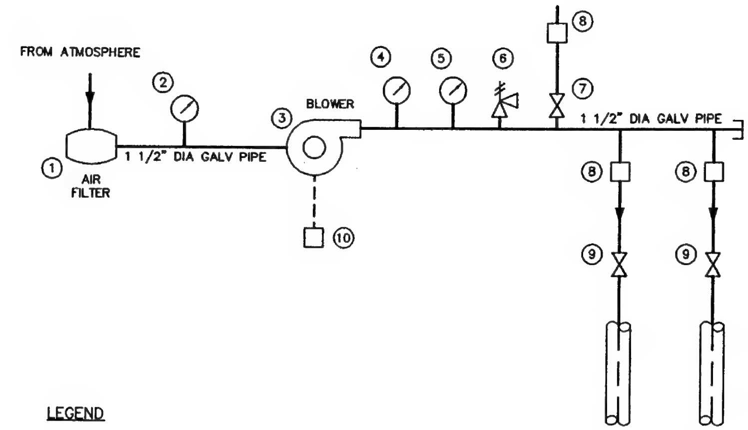
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FT-03
CHARLESTON AIR FORCE BASE

MONITORING POINT STANDARD DETAIL

DRAWING NO G-0.4 | REV A



LEGEND

1. INLET AIR FILTER – SOLBERG F-30P-150, REPLACEMENT ELEMENT 30P
2. VACUUM GAUGE – GAST® AJ497, 2 5/8" DIA., 0–60" H_2O, 1/4" NPT, LM (Part No. AJ497)
3. BLOWER – GAST® 1.5 HP R4P140N-50, 72 CFM AT 40" H_2O PRESSURE
4. TEMPERATURE GAUGE – ASHCROFT, 0–250°F, 1/2" NPT, CBM (Part No. 2A606 FROM GRAINGER)
5. PRESSURE GAUGE – WIKA 611.10, 2 1/2" DIA., 0–100" H_2O, 1/4" NPT, CBM (Part No. 9851879)
6. AUTOMATIC PRESSURE RELIEF VALVE – GAST AG258, SET TO RELEASE AT 50" H_2O PRESSURE
7. MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" GATE
8. FLOW MEASURING PORT FITTED WITH PLUG (1/4"x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)
9. FLOW CONTROL VALVE – 1 1/2" GATE
10. FUSED DISCONNECT SWITCH

1 BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

Job No. 726876.28140					
Designed RAF					
Drawn VW					
Checked	7/11/96				
Reviewed	7/11/96				
Approved	7/11/96				
Reg No		A	7/11/96	85% DESIGN	
Date		Rev	Date	Description	By

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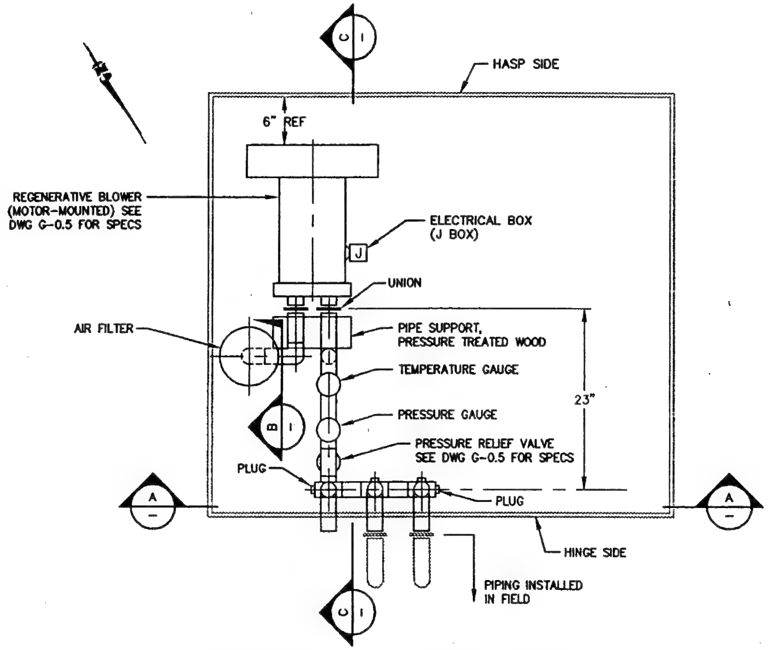
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
EXPANDED BIOVENTING SYSTEM
SITE FT-03
CHARLESTON AIR FORCE BASE

BLOWER P & ID

DRAWING NO G-0.5 REV A

K:\AFCEE\726876\CHRLSTON\96DN0506, 07/11/96 at 11:02

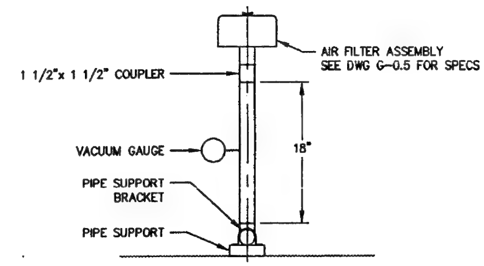


1 — BLOWER PIPING LAYOUT PLAN DETAIL

3/4" = 1'-0"

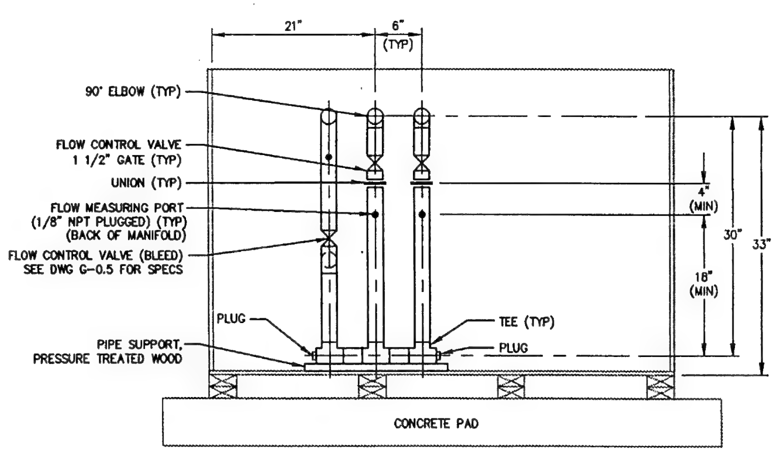
NOTES:

1. SHOP CORE HOLES TO PIPING DIMENSIONS
2. ALL PIPING 1 1/2" DIA. GALVANIZED STEEL, UNLESS OTHERWISE NOTED
3. SEE DRAWING G-0.7 FOR BLOWER BUILDING DETAILS



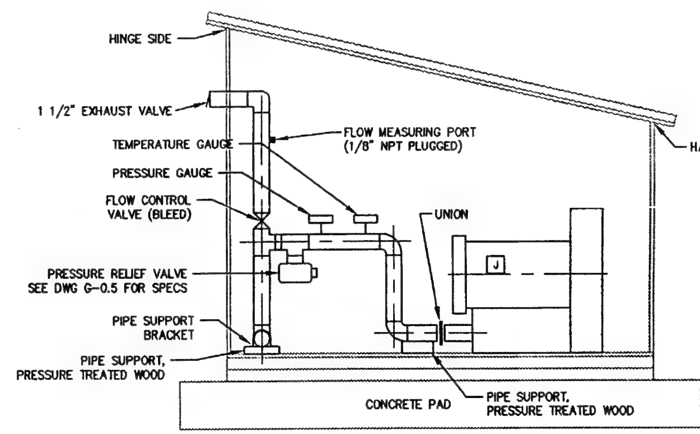
B — BLOWER INLET PIPING SECTION

3/4" = 1'-0"



A — MANIFOLD DETAIL SECTION

3/4" = 1'-0"



C — BLOWER OUTLET PIPING SECTION

3/4" = 1'-0"

Job No. 726876.28140				
Designed RAF				
Drawn MW				
Checked	7/11/96			
Reviewed	7/11/96			
Approved	7/11/96			
Reg No	A	7/11/96	65% DESIGN	
Date	Rev	Date	Description	By

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

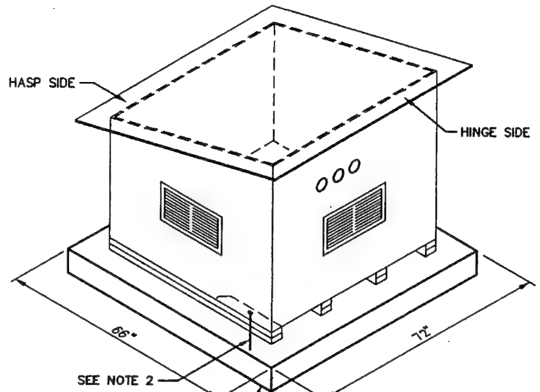
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
SITE FT-03
CHARLESTON AIR FORCE BASE

BLOWER PIPING LAYOUT DETAIL

DRAWING NO G-0.6 — REV A

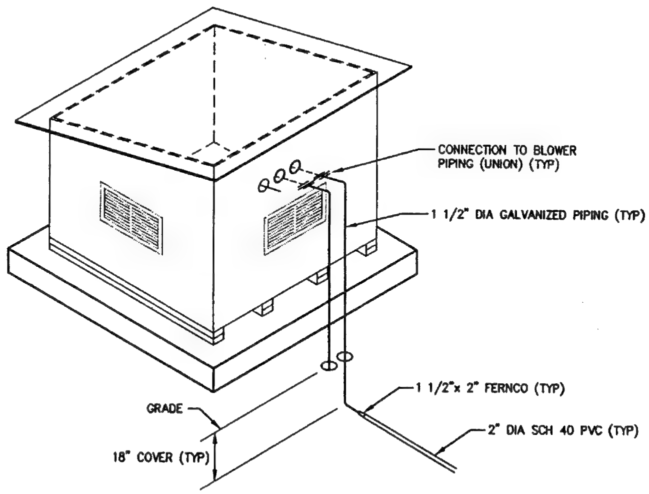
K:\AFCEE\726876\CHRLSTON\96DN0507, 07/11/96 at 11:04



NOTES:
1. FIELD INSTALL BUILDING CENTRAL ON CONCRETE SLAB WITH ORIENTATION AS SHOWN
2. FIELD SECURE BLOWER SHED TO CONCRETE SLAB AT LOCATIONS BY THRU BOLTING. USE 3/8"x 6" LONG ST STL WEDGE ANCHOR BOLTS

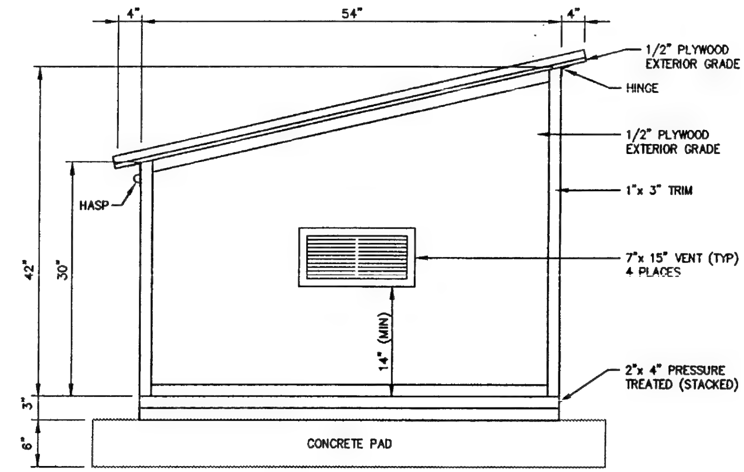
(1/–) BLOWER SHED FIELD INSTALLATION DETAIL

NOT TO SCALE

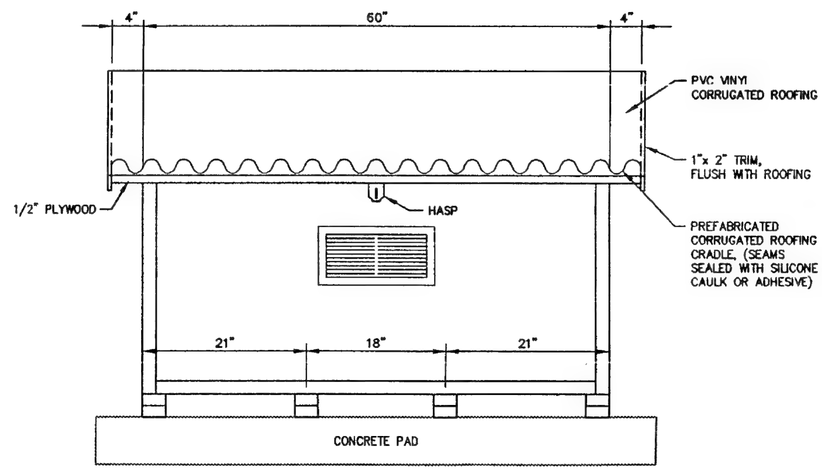


(2/–) TYPICAL MANIFOLD DISCHARGE PIPING LAYOUT

NOT TO SCALE



SIDE ELEVATION



FRONT ELEVATION

NOTES:
1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WITH PVC VINYL CORRUGATED ROOFING

(3/–) BLOWER SHED CONSTRUCTION DETAIL

3/4" = 1'-0"

Job No. 726876.28140				
Designed RAF				
Drawn MW				
Checked RAF	7/11/96			
Reviewed	7/11/96			
Approved	7/11/96			
Reg No	A	7/11/96	65% DESIGN	
Date	Rev	Date	Description	

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado (303) 831-8100

EXPANDED BIOVENTING SYSTEM
SITE FT-03
CHARLESTON AIR FORCE BASE

BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

DRAWING NO G-0.7 | REV A

K: \AFCEE\726876\CHRLSTON\96DN0508, 07/11/96 at 11:06

APPENDIX B

BIOVENTING PILOT TEST COMPLETION REPORT (AFCEE)

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE TEXAS

27 Jun 94

MEMORANDUM FOR 437 SUPPORT GROUP/CEV
ATTN: MR. MARK SMITH

FROM: HQ AFCEE/ERT
8001 Arnold Drive
Brooks AFB TX 78235-5357

SUBJECT: Completion of One-Year Bioventing Test, Fire Training Area, FT-03 (Charleston

The Air Force Center for Environmental Excellence (AFCEE) one-year bioventing test and evaluation project at the Fire Training Area, FT-03 has been completed. Figure 1 provides general site information and Table 1 provides a summary of initial, six-month, and one-year fuel biodegradation rates measured at several monitoring points. Biodegradation rates have varied slightly during the one-year pilot test. Some of these changes can be explained by soil temperature variations. Table 2 provides a summary of initial and final soil and soil gas sampling results for total recoverable petroleum hydrocarbons (TRPH) and benzene, toluene, ethylbenzene, and zylenes (BTEX). Figure 2 is a graphical representation of the soil sampling data. Based on results from your site and 109 other sites currently under operation, bioventing is cost-effectively remediating fuel contamination in a reasonable time frame. We recommend its continued application at other sites on your installation using the criteria in the AFCEE Test Plan and Technical Protocol for a Field Treatability Test for Bioventing, May 92, and Addendum One to Test Plan and Technical Protocol for a Field Treatability Test for Bioventing-Using Soil Gas Surveys to Determine Bioventing Feasibility and Natural Attenuation Potential, Feb 94.

The one-year sampling effort was not intended to collect the large number of samples required for statistical significance. It was conducted to give a qualitative indication of changes in contaminant mass. Soil gas samples are somewhat similar to composite samples in that they are collected over a wider area. Thus, they provide a good indication of changes in soil gas profiles and volatile contaminant mass (see Addendum One). Soil samples, on the other hand, are discrete point samples subject to large variabilities over small distances/soil types. This variability, coupled with known sampling and analytical variabilities, would require the collection of a large number of samples to conclusively determine "real" changes in soil contamination. Due to the limited number of final samples collected under this effort, these results should not be viewed as conclusive indicators of bioventing progress or evidence of the success or failure of this technology. In situ respiration tests are considered to be better indicators of hydrocarbon remediation than limited soil sampling.

Data from your base and many others indicate that BTEX compounds are preferentially biodegraded over TPH. Since BTEX compounds represent the most toxic and mobile fuel constituents, a BTEX standard is a risk-based standard. We strongly encourage its use over an arbitrary TPH standard. Attachment 3 summarizes the BTEX/TPH issue and a report to be sent under separate cover will assist you in negotiating for a BTEX cleanup standard. Our information indicates that South Carolina does not have specific cleanup standards for either BTEX or TPH but bases the ultimate cleanup goal on site specific conditions. We feel such a policy is conducive to negotiating a risk-based approach scenario which will expedite site closure while reducing overall costs.

In general, quantitative destruction of BTEX will occur over a 1 to 2 year bioventing period. Soil gas surveys and respiration tests can be used as BTEX/TPH destruction indicators. In the event that a non-risk-based/TPH cleanup is chosen, a full-scale system should be operated until respiration rates approach background rates. We recommend that confirmatory soil sampling be conducted 4-6 months after background respiration rates are approached.

Sampling results indicate that significant reductions in the BTEX compounds have taken place in the soils within the estimated 30-foot treatment radius of the pilot vent well. In fact all three soil samples collected indicate that the BTEX concentrations are below detection levels. Also note the detection levels shown in Table 2 are well below those required by the South Carolina Department of Health and Environmental Control (i.e., 1 mg/kg BTEX and 10 mg/kg TPH). However, since it appears that the contaminated zone at FT-03 is considerably larger than this 30-foot radius, the results shown in the attached tables can not be considered as representative of the entire site. The oxygen up-take rates shown in Figure 1 indicate that the site is still supporting adequate respiration and degradation rates. Based upon the data in Table 2, AFCEE recommends that the pilot scale bioventing system continue to operate while planning a full-scale expansion of the system with the addition of two additional vent wells. The system expansion can be accomplished through the AFCEE.

Because this is a streamlined test and evaluation project, our contract does not provide for additional reports to the base on pilot study results. The interim results report dated Jan 93 contains as-builts and initial data. This letter summarizes all data collected and provides next step recommendations. AFCEE is no longer responsible for the operation, maintenance, or monitoring of this bioventing system. However, we are in the process of awarding a contract vehicle for extended monitoring, design and expansion of bioventing systems that will be available for your use. Please contact Mr. Marty M. Faile, AFCEE/ERT, DSN 240-4342, COM (210)536-4342, to discuss the technical and contractual options for a full scale expansion.

The blower and accessories are now base property and should continue to be used on this or other bioventing sites. Although current equipment is explosion proof, under no circumstances should it be used for soil vapor extraction unless appropriate explosion-proof wiring is provided. If the base does not want to keep the blower or if you have further questions, please contact us.

On behalf of the AFCEE/ERT staff, I would like to thank you for your support of this bioventing test and evaluation project. The information gained from each site will be invaluable in evaluating this technology and will promote its successful application on other DOD and private sites. I have enclosed a customer satisfaction survey. Please take a few minutes to fill it out and tell us how we did. We look forward to hearing from you.

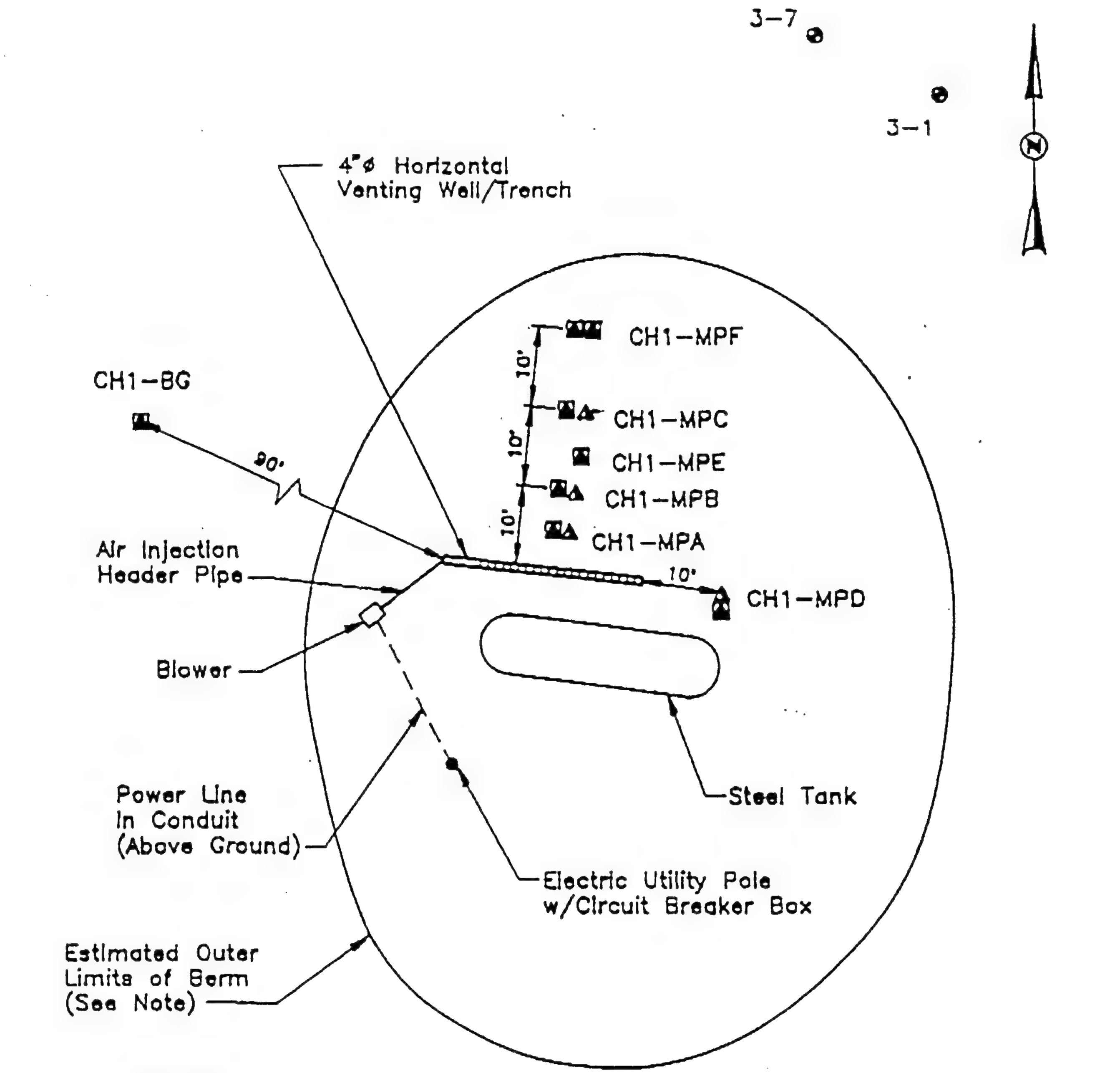
for Marty M. Fal

ROSS N. MILLER, Lt Col, USAF, BSC
Chief, Technology Transfer Division

Attachments:
1. Site Map
2. Analytical Results
3. BTEX Paper
4. Addendum One
5. Survey

cc:
HQ AMC/CEVR
HQ AFCEE/ERD

Figure 1



LEGEND

CH1–MPA ▲	Permanent soil vapor/pressure monitoring point.
CH1–MPA ◙	Temporary soil vapor/pressure monitoring point (soil vapor probe).
CH1–BG ◙	Temporary background monitoring point.
3–7 ●	Groundwater monitoring well.

NOTE: Soil berm has approximate elliptical dimensions.

20' 10' 0 20'

Approximate Scale in Feet

Venting Well, Vapor Monitoring Points, and Blower Locations

Site FT–03
Fire Training Area
Charleston AFB, South Carolina

DC388-08.dwg / 1-20 / 1-25-93 / TLP

TABLE 1
SITE FT-03
RESPIRATION AND DEGRADATION RATES
CHARLESTON AFB, SOUTH CAROLINA

Location-Depth	Initial = November 1992			6-Month = May 1993			1-Year = November 1993		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[b/]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate[d/] (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA-3.5	NA[a/]	NA	NA	0.0046	270	19.7	0.00085	120	16.9
MPB-3.5	NA	NA	NA	0.0018	110	NS	0.00045	60	NS
MPC-3.25	NA	NA	NA	NS[c/]	NS	NS	0.00036	70	NS
MPD-1.8	NA	NA	NA	0.0031	370	NS	0.0028	510	NS
MPD-3.9	0.0088	580	19.0	0.014	1690	19.3	0.0025	450	17.3

a/ Not Available – Point was submerged.
b/ Milligrams hydrocarbons per kilogram soil per year.
c/ Not Sampled.
d/ Assumes moisture content of the soil is average of initial and final moistures.

TABLE 2
SITE FT-03
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
CHARLESTON AFB, SOUTH CAROLINA

Analyte (Units)[a]	Sample Location-Depth (feet below ground surface)					
	MPA-3.5		MPC-3.25		MPD-3.9	
Soil Gas Hydrocarbons	Initial[b]	1-Year[c]	Initial	1-Year	Initial	1-Year
TVH (ppmv)	27	0.47	NS[d]	0.78	790	13
Benzene (ppmv)	<0.002	<0.002	NS	<0.002	<0.04	<0.002
Toluene (ppmv)	<0.002	<0.002	NS	<0.002	<0.04	<0.002
Ethylbenzene (ppmv)	<0.002	<0.002	NS	0.002	0.12	<0.002
Xylenes (ppmv)	0.002	<0.002	NS	<0.002	0.22	<0.002
	VW-3.5		MPA-2.5		MPD-3	
Soil Hydrocarbons	Initial[e]	1-Year[f]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	1,100	170	51	12	2,200	2,200
Benzene (mg/kg)	<0.73	<0.0027	<0.72	<0.0006	<1.4	<0.54
Toluene (mg/kg)	2.6	<0.0027	2.7	<0.0006	<1.1	<0.54
Ethylbenzene (mg/kg)	1.6	<0.0027	<0.6	<0.0006	<1.6	<0.54
Xylenes (mg/kg)	4.6	<0.0038	1.3	<0.0006	<2.1	<0.75
Moisture (%)	17.9	8.5	16.8	9.1	12.6	6.6

[a] TRPH=total recoverable petroleum hydrocarbons; mg/kg=milligrams per kilogram;
TVH= total volatile hydrocarbons; ppmv=parts per million, volume per volume;
[b] Initial soil gas samples collected on May 6, 1993
[c] Final soil gas samples collected on November 11, 1993
[d] NS=not sampled.
[e] Initial soil samples collected on October 29, 1992
[f] Final soil samples collected on November 11, 1993

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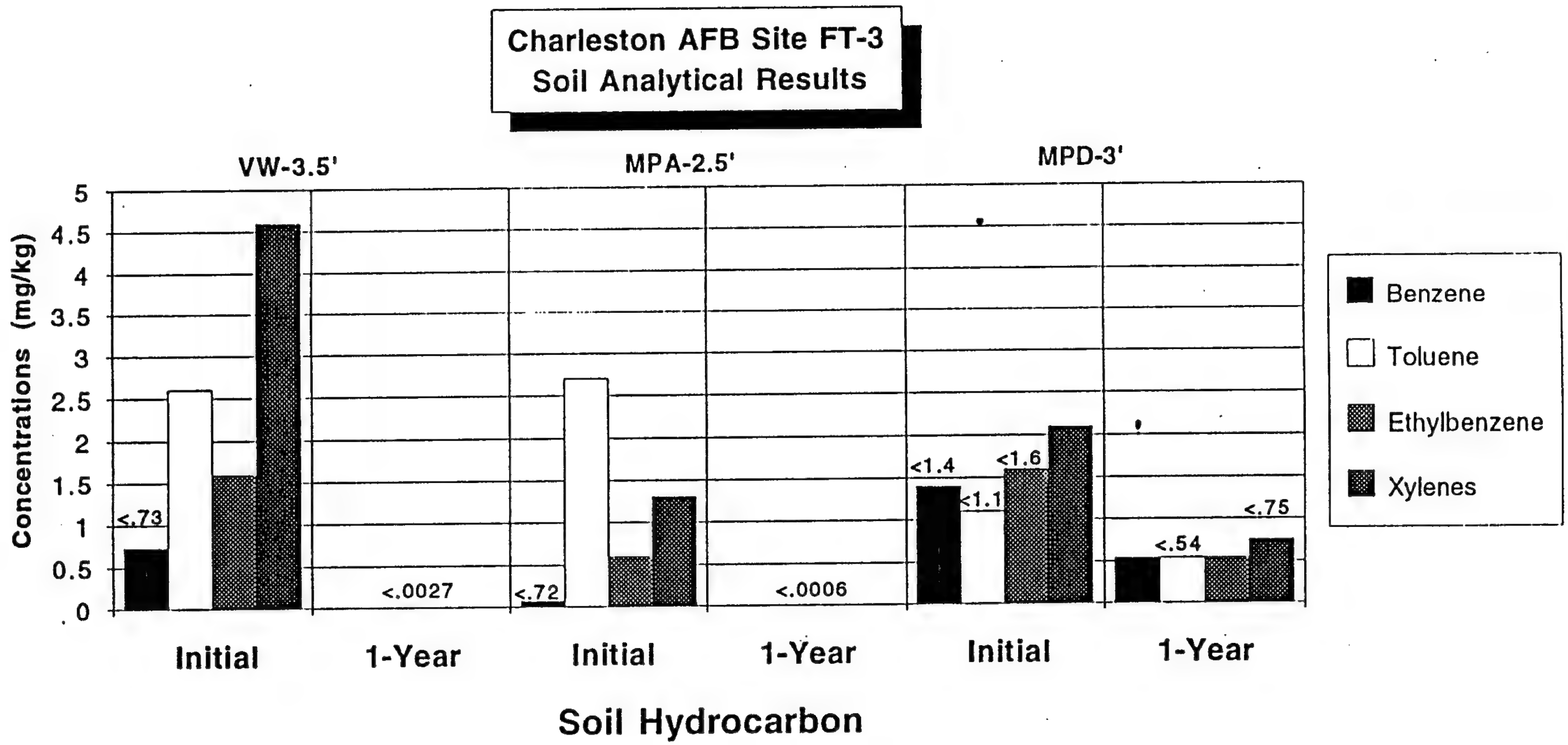
FIGURE 2



Charleston AFB Site FT-3
Soil Analytical Results
VW-3.5'
MPA-2.5'
MPD-3'
Concentrations (mg/kg)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
<.73
<.0027
<.72
<.0006
<1.4
<1.1
<1.6
<.54
<.75
Initial
1-Year
Initial
1-Year
Initial
1-Year
Soil Hydrocarbon
Benzene
Toluene
Ethylbenzene
Xylenes

APPENDIX C
SITE HEALTH AND SAFETY PLAN

Program Health and Safety Plan for Extended Bioventing

Prepared For

Air Force Center for Environmental Excellence
Brooks Air Force Base
San Antonio, Texas

May 1995

PARSONS
ENGINEERING SCIENCE, INC.

1700 Broadway, Suite 900 • Denver, Colorado 80290

PROGRAM HEALTH AND SAFETY PLAN
FOR
EXTENDED BIOVENTING

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

ENVIRONMENTAL RESTORATION TECHNOLOGY (ERT)

BROOKS AIR FORCE BASE, TEXAS 78235-5000

USAF CONTRACT 41624-92-D-8036, DELIVERY ORDER 17

April 1995

Prepared by:

PARSONS ENGINEERING SCIENCE, INC.
1700 Broadway, Suite 900
Denver, Colorado 80290

Reviewed and Approved By:

	Name	Date
Project Manager	Kent A. Grosjn	4/25/95
Office H & S Representative	Timothy S Mustard	4/25/95

022/726876/15.WW6

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

SECTION 1

PURPOSE AND POLICY

The purpose of this program health and safety plan is to establish personnel protection standards and mandatory safety practices for all Parsons Engineering Science, Inc. (Parsons ES) and subcontractor personnel involved in the bioventing monitoring and full-scale design program at numerous US Air Force sites. Parsons ES has prepared this program health and safety plan to complete the extended bioventing program at U.S. Air Force sites contaminated with petroleum hydrocarbons. The plan also provides for contingencies that may arise during field operations. All Parsons ES personnel and subcontractors who engage in field activities will be familiar with this plan and comply with its requirements. This plan provides guidance for general operations on bioventing sites. Site-specific information is not provided in this plan and will be addressed in formal health and safety plan addenda.

A project description and scope of work summary for the project are provided in Section 2. Section 3 presents the project team organization, personnel responsibilities, and lines of authority. Training and medical monitoring requirements are contained in Section 4. Section 5 presents a safety and health risk analysis. Section 6 contains the program emergency response plan. Program requirements for levels of protection are included in Section 7, and air monitoring procedures are provided in Section 8. Site control measures, including designation of site work zones, are contained in Section 9, while Section 10 provides decontamination procedures. Section 11 contains information on the use and calibration of air monitoring equipment. Appendix A contains an example of an Emergency Contacts Form to be used in each formal health and safety plan addenda prepared for all U.S. Air Force Bioventing sites. Appendix B contains a Plan Acceptance Form, Site Specific Training Records, Personal Air Sampling Data Form, Accident Report Form, Daily Health and Safety Report Form, Self Contained Breathing Apparatus (SCBA) Log Forms, and Respirator Use Forms.

SECTION 2

PROJECT DESCRIPTION AND SCOPE OF WORK

2.1 PROJECT DESCRIPTION

Parsons ES and Air Force Center for Environmental Excellence (AFCEE) have developed four contracting options to transition existing and new bioventing pilot systems toward either site closure or expansion into full-scale systems. To complete this task order, Parsons ES will complete remediation monitoring and design and implement full-scale bioventing systems at numerous US Air Force sites. The various tasks that will be performed at these sites is outlined in Section 2.2, Scope of Work.

2.2 SCOPE OF WORK

The objective of the full-scale bioventing program is to extend the operation of existing bioventing pilot systems and to move forward with site closures or design and implementation of full-scale systems. This scope of work was developed through evaluation of previous investigation results, current remediation efforts, and results of a bioventing pilot test at other Air Force sites. This project will include the following four potential options for each site:

Option 1: An additional one year of testing for existing bioventing systems.

Option 2: Closure soil sampling for sites which have demonstrated bioventing success.

Option 3: Complete an initial bioventing test at new sites.

Option 4: Design and installation of a multiple-vent well, full-scale system.

Specific field activities will likely involve the following field tasks as defined by Options 1-4.

Option 1 Repair and replacement of damaged equipment such as blower units, air filters, pressure gauges; general system repairs; respiration testing and collection of soil gas samples.

Option 2 Complete closure soil sampling involving GeoProbe® direct push technology or conventional auger drilling and drill cuttings handling and disposal of investigation derived wastes (IDW).

Option 3 Installation of blowers and pilot systems including vent wells, monitoring points, drill cutting disposal, soil sampling, and soil gas collection.

Option 4 Expanding the existing bioventing pilot systems to full-scale systems by adding vent wells and installing an upgraded blower package.

SECTION 3

PROGRAM TEAM ORGANIZATION

The Parsons ES team assigned to the extended bioventing program, their responsibilities, and lines of authority are outlined below.

Name	Task Assigned
Mr. Ernie Schroeder	Program Manager
Mr. Doug Downey	Technical Director
Mr. John Ratz	Project Manager
Mr. Timothy Mustard	Program Health and Safety Manager
To be assigned	Site Managers
Lt. Maryann Jenner	Contact - AFCEE ERT

The program manager shall be responsible for the overall management of tasks performed under this contract and shall be the primary point-of-contact between AFCEE and Parsons ES. He will be responsible for ensuring that practical and effective systems are developed to meet the specified objectives. The program manager shall also ensure that quality work is accomplished on schedule.

The technical director is responsible for conduct and review of all technical work on this project to ensure technical accuracy and adequacy. He will provide advice to the project manager and project personnel on technical issues.

The project manager is directly responsible for the execution of all phases of this project. He is responsible for planning, staffing, assuring adequate planning for health and safety and quality assurance/quality control (QA/QC), execution of each phase, coordination with AFCEE, and interpretation of data and reporting. The project manager will also coordinate with the site managers to obtain permission for site access, coordination of activities with appropriate officials, and serve as the liaison with public officials.

The program health and safety manager will be responsible for updating and revising the program health and safety plan, as necessary. He will arrange for periodic field audits to ensure that the provisions of the health and safety plan are being enforced.

The site managers will prepare documents for regulatory approval, complete bioventing extended testing and final soil sampling, and construct full-scale systems. In addition, they will assist with day-to-day scheduling, budgeting, and reporting.

SECTION 4

SITE-SPECIFIC EMPLOYEE TRAINING AND MEDICAL MONITORING REQUIREMENTS

The Parsons ES Corporate Health and Safety Manual, incorporated by reference, presents general requirements for Parsons ES employee training and medical monitoring. All field team members will have completed the 40-hour basic health and safety training as specified in 29 CFR 1910.120(e) and the 8-hour annual refresher training thereafter. All supervisory personnel onsite will be required to have completed an 8-hour supervisor course as required in 29 CFR 1910.120(e).

In addition to the 40-hour course, all field employees will be required to have completed a minimum of 3 days onsite training under the supervision of a trained and experienced supervisor. Employees will not participate in field activities until they have been trained to the level required by their job function and responsibility. In addition, at least one person on every Parsons ES crew involved in field activities will have completed Red Cross or equivalent first-aid and cardiopulmonary resuscitation (CPR) courses. All training documentation for Parsons ES personnel will be verified by the SHSO and maintained by the Health and Safety Manager.

All field team members will be on current medical monitoring programs in accordance with federal OSHA requirements (29 CFR 1910.120) and Parsons ES corporate policies. Listed below are additional health and safety training and medical monitoring requirements for this project.

4.1 ADDITIONAL SAFETY TRAINING REQUIREMENTS

Additional training may be required for personnel involved in Level B (SCBA) respiratory protection. This training would be conducted onsite as necessary by a qualified, Level B-experienced supervisor. Employees will also be trained in use, care, maintenance, limitations, and disposal of personal protective equipment in accordance with 29 CFR 1910.132. All field team members must have site-specific training as discussed in the following section.

4.1.1 Site-Specific Safety Briefings

Site-specific safety and health briefings will be conducted by the Parsons ES site manager or site health and safety officer for all personnel who will engage in any extended bioventing activities. Site-specific safety briefings will address the activities, procedures, monitoring, and equipment applicable to the site's operations, as well as

site or facility layout, potential hazards, and emergency response services at the site. Additional topics that will be addressed at the safety briefings will include:

- Names of responsible health and safety personnel;
- Identification of site hazards;
- Site contingencies and emergency procedures;
- Exposure risk;
- Symptoms of exposure and exposure treatment for chemical contaminants;
- Personal protective equipment (PPE) to be used;
- Decontamination procedures to be followed;
- Location of safety equipment;
- Review of planned activities;
- Defined safety procedures to be followed during installation, system repairs and sampling activities; and
- Emergency and evacuation procedures.

Safety briefings will be conducted as needed prior to initiating extended bioventing field activities.

4.2 MEDICAL MONITORING REQUIREMENTS

Prior to being assigned to the field activities, each Parsons ES employee will receive a preassignment or baseline physical examination. Preassignment screening has two major functions: 1) determination of an individual's fitness for duty, including the ability to perform work while wearing PPE; and 2) provision of baseline data for comparison with future medical data. Medical qualification/certification documentation will be maintained by the program health and safety manager. All medical examinations and procedures will be performed by or under the supervision of a licensed physician, preferably an occupational physician. The examination content will be determined by the examining physician in accordance with 29 CFR 1910.120(f).

SECTION 5

SAFETY AND HEALTH RISK ANALYSIS

5.1 CHEMICAL HAZARDS

The chemicals of primary concern occurring at the majority of U.S. Air Force sites are those originating from gasoline, diesel fuel, and jet fuels. Some of these sites may be contaminated with trichloroethene (TCE) or other chlorinated solvents. The properties of gasoline, diesel fuel, and jet fuel and several of its volatile constituents are summarized in Table 5.1. If other compounds are discovered at these sites, the health and safety plan will be amended, and the pertinent information about these compounds will be provided in Table 5.1. The health hazards or other physical/chemical hazards (e.g., corrosiveness, flammability) of the compounds will then be communicated to the onsite employees.

Hazardous substances of primary concern identified at U.S. Air Force sites, are those potentially occurring in contaminated groundwater, soils, sediment, surface water, air, and buildings, or abandoned structures.

5.2 PHYSICAL HAZARDS

In addition to the hazardous substances and conditions potentially present at U.S. Air Force sites, other physical hazards or hazardous conditions may be expected at the site during the course of performing extended bioventing activities. These hazards include possible risks from injury while working around motor vehicles; stationary or moving equipment; fire or explosion hazards; slip, trip, and fall hazards; excavation activities; subsurface investigations; electrical hazards; and excessive noise conditions. Additional physical hazards include heat stress and cold-related exposures. The following subsections further describe these physical hazard concerns.

5.2.1 Motor Vehicles and Heavy Equipment

Large motor vehicles and heavy equipment represent a potential safety hazard at remediation sites. Injuries can result from equipment dislodging, striking unsuspected personnel, and impacts from flying objects or overturning of vehicles. Vehicles and heavy equipment design and operation will be in accordance with 29 CFR, Subpart 0, 1926.600 through 1926.602. In particular, the following precautions will be used to minimize or avoid injuries and accidents:

TABLE 5.1
HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold [d/] (ppm)	Ionization Potential [e/] (eV)	Physical Description/Health Effects/Symptoms
Benzene	1 (29 CFR 1910.1028) [f/]	10	3,000	4.7	9.24	Colorless to light−yellow liquid with aromatic odor. Eye, nose and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, and bone marrow depression. Chronic exposure has been linked to leukemia. Carcinogen.
Ethylbenzene	100	100	2,000	0.25−200	8.76	Colorless liquid with an aromatic odor Eye, skin, and mucous membrane irritant. Causes headaches, narcosis, coma.
Gasoline	300	300	NA	0.005−10	NA	Clear/amber flammable, volatile liquid with a characteristic odor. Avoid skin and eye contact. Vapors may result in euphoria, respiratory arrest, and CNS toxicity. Monitor for BTEX constituents.
Jet Fuel	400 [g/]	300 [g/]	10,000 [g/]	0.08−1	NA	Colorless to light brown liquid with a fuel−like odor. Long−term effects include liver, kidney, and CNS damage.
Toluene	100	50 (skin) [h/]	2,000	0.2−40 [i/]	8.82	Colorless liquid with sweet, pungent odor. Causes dizziness, headache, dilated pupils. Targets skin, liver, kidneys, and CNS. Suspected teratogen and mutagen.

TABLE 5.1
HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold [d/] (ppm)	Ionization Potential [e/] (eV)	Physical Description/Health Effects/Symptoms
Trichloroethene (TCE)	50	50	1,000	21.4–400	9.45	Clear colorless or blue liquid. Ethereal, chloroform–like odor. Skin and eye irritant. Causes headaches, vertigo, visual disturbances, tremors, nausea, vomiting, and cardiac arrhythmia. Carcinogen.
Xylene (o–, m–, p–isomers)	100	100	1,000	0.05–200 [i/]	8.5	Colorless liquid with aromatic odor. Causes dizziness, drowsiness, staggered gait, irritation of eyes, nose, skin, and throat, nausea, vomiting, and abdominal pain. Also targets blood, liver, kidneys, and skin.

a/ PEL = Permissible Exposure Limit. OSHA–enforced average air concentration to which a worker may be exposed for an 8–hour workday without harm. PELs published in 29 CFR 1910.1000, 1989. Expressed as parts per million (ppm) unless noted otherwise. Some states (such as California) may have more restrictive PELs. Check state regulations.
b/ TLV = Threshold Limit Value – Time–Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), 1994–1995.
c/ IDLH = Immediately Dangerous to Life or Health. Air concentration at which an unprotected worker can escape without debilitating injury or health effects. Expressed as ppm unless noted otherwise.
d/ When a range is given, use the highest concentration.
e/ Ionization Potential, measured in electron volts (eV), necessary to determine if field air monitoring equipment can detect substance.
f/ Refer to expanded rules for this compound.
g/ Based on exposure limits for petroleum distillates (naphtha).
h/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.
i/ Olfactory fatigue has been reported for compound and odor may not serve as warning property.

- Mobile equipment brakes, hydraulic lines, light signals, fire extinguishers, fluid levels, steering, tires, horn, and other safety devices will be routinely inspected prior to each work shift.

- Heavy equipment or motor vehicle cabs will be kept free of all nonessential items, and all loose items will be secured.

- Construction and heavy equipment (specifically Geoprobe® operations), will be provided with necessary safety equipment including seat belts, rollover protection, emergency shutoff during rollover, backup warning lights, and audible backup alarms.

Motor vehicles and equipment will be used to perform a portion of the onsite work activities including excavation and backfill, concrete and structural demolition, transportation of earthen materials and debris, and loading of waste materials for transportation offsite. Equipment safety will be addressed during daily tailgate safety meetings, in addition to other operational hazards and concerns that may be anticipated. All field team members and subcontractors assigned to operate heavy equipment will have demonstrated sufficient competence and ability prior to their assignment. Equipment operators and all other field supervisory and support personnel will adhere to following general guidelines:

- Protective clothing and equipment as specified in this HSP and site-specific HSPs will be worn as appropriate to complete the task safely.

- Hand signal communications will be established when verbal or radio communication is difficult or impractical. Only one person will give hand signals to an equipment operator.

- Personnel will never walk directly behind or to the side of operating equipment without the operator's knowledge.

- When operating heavy equipment (such as drilling rigs) near power lines, workers will ensure that the boom or rigging always maintains a safe distance from power lines (20 feet minimum). Any underground utility lines must also be located, and appropriate measures taken before any excavation work or drilling is performed.

- Only qualified operators will be allowed to operate heavy equipment, in accordance with the safe work guidelines included in the OSHA General Industry (29 CFR 1910) and Construction Industry (29 CFR 1926) standards.

- Under no circumstances will any piece of equipment or machinery be modified or used in a manner that may violate the manufacturer's recommended capacity, safety guidelines, or its intended use.

- If any field team members have questions or doubts regarding the safety of any particular activity, he/she will bring it to the attention of his/her supervisor prior to performing the activity.

These guidelines address procedures that are applicable to all types of equipment that may be used during the extended bioventing program at U.S. Air Force Installations Individual equipment types or certain specialized equipment may require additional safety considerations or specialized training prior to its use. Should any specialized equipment be required during the performance of a task, the Program Health and Safety Manager will ensure that operators receive appropriate training. The Program Health and Safety Manager is also responsible for ensuring that all equipment is routinely inspected and that any piece of equipment considered unsafe is not used until the unsafe conditions are corrected or repaired.

5.2.2 Slip, Trip, and Fall Hazards

Remedial activities and existing site conditions may pose a number of slip, trip, and fall hazards, such as:

- Open excavations, pits, or trenches;
- Slippery surfaces;
- Steep or uneven grades;
- Surface obstructions; and
- Construction materials or debris.

All field team members will be instructed to be cognizant of potential safety hazards and immediately inform the SSHO or the site manager about any new hazards. If the hazard cannot be immediately removed, actions must be taken to warn site workers about the hazard. The site will be kept in a neat, organized, and orderly fashion. Rubbish, trash, or debris generated by the project team shall be picked up and properly disposed of on a daily basis. Items such as tools, equipment, and hoses will be properly stored when not in use.

5.2.3 Subsurface Investigations

Before intrusive operations (drilling, soil gas activities, cone penetrometer) are initiated, efforts will be made to determine whether underground installations, (e.g., sewers, telephone, water, fuel, and electric lines) will be encountered and, if so, where such underground installations are located. Site managers will verify that all underground installations have been identified prior to any intrusive operations.

5.2.4 Excavation Activities

Excavation areas in which Parsons ES team members may be expected to enter will be protected as required by adequate shoring or sloping. OSHA excavation, trenching, and shoring standards will be followed as listed in 29 CFR 1926, Subpart P. Excavations may require either structural support, adequate sloping, or a combination of both in order to ensure adequate worker safety. A professional engineer from the Parsons team will design any protective systems (sloping, shoring, or shielding) for

such excavations that are 4 feet or greater in depth and the plans will be maintained and available for inspection onsite.

The following procedures will be strictly adhered to during excavation or trenching activities:

- Prior to initiation of excavation activities all underground utility installations and structures (sewer, water, fuel, electric lines) shall be located and protected from damage or displacement.

- In excavations where oxygen-deficient or hazardous atmospheres may exist, the work area shall be tested prior to worker entry.

- Excavated materials will be placed no closer than 2 feet from the sidewall of the excavation or trench.

- Whenever personnel are required to enter excavations 4 feet deep or greater, access (stairs, ladders, or ramps) shall be used and shall be laterally spaced no greater than 25 feet apart.

- Trenches shall be completely guarded or barricaded on all sides.

- Adequate guards or barricades or flagging shall be placed within 1 to 5 feet from the edge of open excavations. Perimeter protection will be displayed at 3 to 4 feet above ground level. Such barriers shall remain in place until excavation activities are completed and backfilled.

- The walls and spaces of all excavations and trenches greater than 4 feet in depth shall be protected by shoring, sloping of the ground, or equivalent methods.

- Open excavations shall be inspected daily. If there is evidence of sloughing, cave-ins or slides, all work in the excavation shall cease until the necessary safeguards have been implemented.

- All trenches shall be backfilled as soon as practical after work is completed and all associated equipment removed.

- All material and equipment such as pipe and reinforcing steel shall be kept out of traffic lanes and access ways. When not in use, equipment shall be stored out of traffic areas.

5.2.5 Electrical Hazards

Some of the equipment used during field tasks performed at U.S. Air Force sites will be operated by electricity. Maintenance and day-to-day activities require personnel to handle and control this equipment. Unless safe work practices are strictly observed, serious injury or death can result.

Ordinary 120 volt (V) electricity may be fatal. Extensive studies have shown that currents as low as 10 to 15 milliamps (mA) can cause loss of muscle control and that 12 V may, on good contact, cause injury. Therefore, all voltages should be considered dangerous. All electricity should be treated cautiously by trained personnel.

Electricity can paralyze the nervous system and stop muscular action. Frequently, electricity may affect the breathing center at the base of the brain and interrupt the transmission of the nervous impulses to the muscles responsible for breathing. In other cases, the electrical current directly affects the heart, causing it to cease pumping blood. Death follows from lack of oxygen in the body. It cannot be determined which action has taken place; therefore, a victim must be freed from the live conductor promptly by use of a nonconducting implement, such as a piece of wood, or by turning off the electricity to at least this point of contact. Bare hands should never be used to remove a live wire from a victim or a victim from an electrical source. Artificial respiration or CPR should be applied immediately and continuously until breathing is restored, or until a physician or emergency medical technician arrives. General rules for recognizing electrical safety are provided below.

- Only authorized and qualified personnel will perform electrical installations or repairs.
- Rubber mats will be placed in front of electrical panels.
- All electrical wires and circuits will be assumed to be "live," unless absolutely certain they are not.
- Appropriate protective clothing, including rubber gloves and boots, will be worn by personnel performing electrical work.
- Ground fault circuit interrupter receptacles and circuit breakers will be installed where required by the National Electric Code (NFPA 70).
- Electrical control panels will not be opened unless the job requires it.
- No safety device will be made inoperative by removing guards, using oversized fuses, or blocking or bypassing protective devices, unless it is absolutely essential to the repair or maintenance activity, and then only after alerting operating personnel and the maintenance supervisor.
- All power tools will have insulated handles, be electrically grounded, or be double insulated.
- Fuse pullers will be used to change fuses.
- Metal ladders, metal tape measures, or other metal tools will not be used around electrical equipment.
- Wires and extension cords will be placed or arranged so as to not pose a tripping hazard.

5.2.6 Noise-Induced Hearing Loss

Work onsite may involve the use of heavy equipment such as a drill rig, compressor, generator, blower units and excavation equipment. The unprotected exposure of site workers to this noise or to aircraft noise during site activities can result in noise induced hearing loss. Drilling rigs and associated equipment can emit noise levels exceeding the federal OSHA time-weighted average (TWA) limit of 85 decibels (dB). All drill rig and nearby personnel will be required to wear hearing protection necessary to mitigate noise levels to below OSHA TWA. Foam ear plugs will generally provide adequate protection. The SHSO will ensure that either ear muffs or disposable foam earplugs are made available to, and used by, all personnel in the vicinity of the operation of heavy equipment, aircraft noise or other sources of high intensity noise.

5.2.7 Fire or Explosion Hazards

Jet fuel and possibly some solvents have been released into the soils at many of the U.S. Air Force sites. Vapors escaping from the soils may be flammable or explosive (especially if in a confined space). Therefore, precautions should be taken when performing field work (drilling or well construction/installation) to ensure that combustible or explosive vapors have not accumulated, or that an ignition source is not introduced into a flammable atmosphere.

5.2.8 Effects and Prevention of Heat Stress

Adverse weather conditions are important considerations in planning and conducting site operations. Hot or cold weather can cause physical discomfort, loss of efficiency, and personal injury. These condition are discussed further below.

If work on this project is conducted in the warm months, or if PPE is used, heat stress may be a concern. Monitoring of personnel wearing PPE will commence when ambient temperature is 70°F or above. Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur. They can range from mild symptoms such as fatigue; irritability; anxiety; and decreased concentration, dexterity, or movement; to death. Medical help must be obtained for the more serious cases of heat stress. One or more of the following actions will help reduce heat stress:

- Provide plenty of liquids. To replace body fluids (water and electrolytes) lost due to perspiration, use a 0.1 percent salt water solution, heavily salted foods, or commercial mixes. The commercial mixes may be preferable for those employees on a low-sodium diet.

- Provide cooling devices (such as water jackets or ice vests) to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker efficiency.

- Wear long cotton underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.

- Install portable emergency showers and/or hose-down facilities to reduce body temperature and to cool protective clothing.

- In extremely hot weather, conduct non-emergency response operations in the early morning or evening.

- Ensure that adequate shelter is available to protect personnel against sun, heat, or other adverse weather conditions which decrease physical efficiency and increase the probability of accidents.

- In hot weather, rotate workers wearing protective clothing.

- Maintain good hygienic standards, frequently changing clothing and showering daily. Clothing should be permitted to dry during rest periods. Workers who notice skin problems should immediately consult the SSHO.

5.2.8.1 Heat-Related Problems

- Heat rash: Caused by continuous exposure to heat and humid air, and aggravated by chafing clothes. Decreases ability to tolerate heat and is a nuisance.
- Heat cramps: Caused by profuse perspiration with inadequate fluid intake and chemical replacement, especially salts. Signs include muscle spasm and pain in the extremities and abdomen.
- Heat exhaustion: Caused by increased stress on various organs to meet increased demands to cool the body. Signs include shortness of breath; increased pulse rate (120-200 beats per minute); pale, cool, moist skin; profuse sweating; and dizziness and lassitude.
- Heat stroke: The most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and possibly coma. Medical help must be obtained immediately.

5.2.8.2 Heat-Stress Monitoring

Monitoring of personnel wearing impermeable clothing will begin when the ambient temperature is 70°F (21°C) or above. Table 5.2 presents the suggested frequency for such monitoring. Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed. Heat-stress monitoring will be performed by a person with current first-aid certification who is trained to recognize heat-stress symptoms. For monitoring the body's recuperative capabilities in response to excess heat, one or more of the techniques listed below will be used. Other methods of heat-stress monitoring, such as the wet-bulb globe temperature index from the American Conference of Governmental Industrial Hygienists (ACGIH) (1992) Threshold Limit Value (TLV) Booklet may be used.

TABLE 5.2

SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS[a]

Adjusted Temperature[b]	Normal Work Ensemble[c]	Impermeable Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5° - 90°F (30.8°- 32.2° C)	After each 60 minutes of work	After each 30 minutes of work
82.5° -87.5° F (28.1°- -30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5° F (25.3°- 28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5° -25.3°C)	After each 150 minutes of work	After each 120 minutes of work

a For work levels of 250 kilocalories/per hour.

b Calculate the adjusted air temperature (ta adj) by using this equation: ta adj = ta °F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent of time the sun is not covered by clouds that are thick enough to produce a shadow (100 percent sunshine - no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows).

c A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and trousers.

d Saranex®, Poly-Coated Tyvek®, Etc.

To monitor the worker, measure:

- Heart rate: Count the radial pulse during a 30-second period as early as possible during the rest period.
  - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will remain the same.
  - If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be reduced by one-third.
- Oral temperature: Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).
  - If oral temperature exceeds 99.6° (37.6°C), the next work cycle will be reduced by one-third without changing the rest period.
  - If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, the following work cycle will be reduced by one-third.
  - No worker will be permitted to wear a semipermeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

5.2.9 Cold Exposure

It is possible that work on this project may be conducted during the winter months; therefore, injury due to cold exposure may become a problem for field personnel. Cold exposure symptoms, including hypothermia and frostbite, will be monitored when personnel are exposed to low temperatures for extended periods of time.

Persons working outdoors in temperatures at or below freezing may suffer from cold exposure. During prolonged outdoor periods with inadequate clothing, effects of cold exposure may even occur at temperatures well above freezing. Cold exposure may cause severe injury by freezing exposed body surfaces (frostbite), or may result in profound generalized cooling (hypothermia), possibly causing death. Areas of the body which have high surface area-to-volume ratios such as fingers, toes, and ears are the most susceptible to frostbite.

Two factors influence the development of a cold injury: ambient temperature and wind velocity. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. For example, 14°F with a wind speed of 15 miles per hour (mph) is equivalent in chilling effect to still air at -18°F. Cold exposure is particularly a threat to the hazardous waste site worker if the body cools suddenly when chemical-protective equipment is removed and the clothing underneath is perspiration-soaked. The presence of wind greatly increases the rate of cooling.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- Frost nip or incipient frostbite: characterized by suddenly blanching or whitening of skin.

- Superficial frostbite: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.

- Deep frostbite: tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia, or lowering of the core body temperature, is caused by exposure to freezing or rapidly dropping temperatures. Symptoms are usually exhibited in five stages:

- Shivering and uncoordination;
- Apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F (35°C);
- Unconsciousness, glassy stare, slow pulse, and slow respiratory rate;
- Freezing of the extremities; and
- Death.

5.2.9.1 Evaluation and Control

TLVs recommended for properly clothed workers for periods of work at temperatures below freezing are shown in Table 5.3. For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of -32°C (-25.6°F). Superficial or deep local tissue freezing will occur only at temperatures below -1°C (30.3°F) regardless of wind speed.

Special protection of the hands is required to maintain manual dexterity for the prevention of accidents. If fine work is to be performed with bare hands for more than 10 to 20 minutes in an environment below 16°C (60.8°F), special provisions should be established for keeping the workers' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be used. At temperatures below -1°C (30.2°F), metal handles of tools and control bars should be covered by thermal insulating material.

To prevent contact frostbite, workers should wear gloves. When cold surfaces below -7°C (19.4°F) are within reach, a warning will be given to the workers by the supervisor or SSHO to prevent inadvertent contact with bare skin. If the air temperature is -17.5°C (0°F) or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

Provisions for additional total body protection are required if work is performed in an environment at or below 4°C (39.2°F). The workers will wear cold protective

TABLE 5.3

Threshold Limit Values Work/Warm-up Schedule for Four-Hour Shift

Air Temperature - Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx.)	°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm. Breaks)	1	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4
-29° to -31°	-20° to -24°	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4	30 min	5
-32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease			
-38° to -39°	-35° to -39°	40 min	4	30 min	5	Non-emergency work should cease					
-40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease							
-43° & below	-45° & below	Non-emergency work should cease									

Notes for Table 5.3

1. Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For light-to-moderate work (limited physical movement): apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4 hour period (Step 5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph; light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.

3. In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

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clothing appropriate for the level of cold and physical activity. If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removable windbreak garment. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work will be modified or suspended until adequate clothing is made available or until weather conditions improve.

5.2.9.2 Work-Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) below -7°C (19.4°F), heated warming shelters (tents, cabins, rest rooms) will be made available nearby. The workers will be encouraged to use these shelters at regular intervals, the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, frostnip, the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to the shelter. When entering the heated shelter, the outer layer of clothing should be removed and the remainder of the clothing loosened to permit sweat evaporation or a change of dry work clothing provided. A change of dry work clothing may be necessary to prevent workers from returning to work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of the diuretic and circulatory effects.

For work practices at or below -12°C (10.4°F) ECT, the following should apply:

- The workers will be under constant protective observation (buddy system or supervision).
- The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods will be taken in unheated shelters and opportunity for changing into dry clothing should be provided.
- New employees should not be required to work full-time in the cold during the first days of employment until they become accustomed to the working conditions and required protective clothing.
- The weight and bulkiness of clothing should be included in estimating the required work performances and weights to be lifted by the worker.
- The work should be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats will not be used. The worker should be protected from drafts to the greatest extent possible.
- The workers will be instructed in safety and health procedures relative to cold exposures.

5.3 BIOLOGICAL HAZARDS

Various biological hazards may be encountered at many of the U.S. Air Force Installations. These include pathogenic organisms/diseases such as Hantavirus, Bubonic Plague, Equine Encephalitis, Rocky Mountain Spotted Fever, and Lyme Disease. Other biological hazards include insects, snakes, spiders, and cactus.

Hantavirus has been reported from the "Four Corners" area of the southwestern U.S. The Four Corners strain of Hantavirus has had a 60 percent mortality rate. Deer mice are the primary reservoir for the virus. The virus is excreted in mouse feces, urine, and saliva. Humans may become infected if the virus is inhaled or absorbed through breaks in the skin, by ingesting contaminated food or water, or by being bitten by an infected rodent.

The incubation period for Hantavirus may be three days to six weeks. Symptoms include fever, chills, headache, dizziness, muscle aches, dry cough, nausea, vomiting, abdominal cramps, diarrhea, and shortness of breath. Progression of the disease leads to fluid in the lungs, heart irregularities, and kidney failure. Personnel will use high efficiency particulate air (HEPA) filter-equipped air-purifying respirators when working in rodent-infested areas or when entering sheds of buildings containing mice infestations.

Bubonic plague is a bacterial disease which is spread to humans by fleas that have bitten an infected animal.

Bubonic plague displays symptoms rapidly. Chills and fever are soon accompanied by swelling of the lymph nodes, usually on one side of the body. These painful swellings are usually dark blue to black, hence the other popular name for this disease, "black death." The disease is treatable with antibiotics.

Field personnel will wear Tyvek® suits with leg seams taped to boots or boot covers in prairie dog towns to minimize contact with fleas.

Equine encephalitis, an inflammation of the brain, can be carried by mosquitoes. Field personnel must wear long-sleeved clothing and/or use insect repellents if they are working in areas of mosquito infestations.

Bites from wood ticks may result in the transmission of Rocky Mountain Spotted Fever - a serious and often fatal viral disease. The Rickettsia virus infects wood ticks, which can bite humans and transfer the virus into the bloodstream. Rocky Mountain Spotted Fever occurs mostly in the late spring and early summer, and is characterized by a red rash around a tick bite, chills, fever, severe pain in leg muscles and joints, and a body rash. Lyme Disease exhibits similar symptoms. Prompt medical treatment with antibiotics is usually successful in preventing further complications from these diseases. Personal protective equipment will offer some protection, but the use of insect repellent may also be warranted. Personnel should perform self-searches after each day to check for ticks.

The potential for contact with snakes or insects which may cause injury or disease exists when performing bioventing activities at U.S. Air Force Installations. There are plants which may be injurious (i.e., thorns) as well. Sturdy work clothes and shoes will be worn by field personnel to help prevent injuries. Personnel should be aware that rattlesnakes may be present in the area and should exercise caution, especially when working in previously undisturbed areas and locations around animal dens.

Poison ivy, poison oak, and poison sumac can be encountered at many Air Force Installations. Poison ivy is a woody vine leaves are divided into three leaflets. Poison oak is a low branching shrub with leaflets also in threes. Poison sumac is a shrub or small tree occurring in swamps. Poison sumac have 7 to 13 leaflets which resemble those of green ash trees. All of these species are poisonous and can cause contact dermatitis. Personnel must wear Tyveck® suits or other protective clothing when working in areas containing these plant species.

Black widow spiders and scorpions may be present onsite. The black widow spider has a shiny black body about the size of a pea, with a red or yellow hourglass-shaped mark on its abdomen. It weaves shapeless diffuse webs in undisturbed areas. A bite may result in severe pain, illness, and possible death from complications, but usually not from the bite itself. There are several types of scorpions native to the United States. Scorpions may be brown to yellowish in color, and range from 1/2 inch to 8 inches in length. Their bodies are divided into two parts - a short thick upper body, and a long abdomen with a six-segmented tail. A scorpion has six pairs of jointed appendages - one pair of small pincers, one pair of large claws, and four pairs of jointed legs. They are most active at night. A scorpion sting is very painful, but usually will not result in death.

In addition to spiders and scorpions, bees and wasps may be nuisances to field personnel. Properly trained personnel will administer first aid should a bee or wasp sting occur.

5.4 HAZARD EVALUATION

Within the U.S. Air Force sites and their respective surroundings, personnel conducting field activities may be potentially exposed to certain groups of chemical toxicants by both the respiratory and skin absorption routes. The risk of exposure and the severity of the resultant physiologic reaction to any of the contaminants previously identified are determined chiefly by inherent toxicity, concentration, physical characteristics, duration of exposure, and individual work susceptibility or hypersensitivity.

Complete descriptions of the known chemical compounds that may be encountered during onsite investigations are listed in Table 5.1. Most of the contaminants listed in Table 5.1 were identified based on historical uses of the particular Air Force site and on results of previous Parsons ES bioventing pilot studies.

During site activities, all personnel must assume that disturbance of various physical media (e.g., soil, sediments, purged groundwater) could potentially result in worker exposures to any of the contaminants identified in Table 5.1. Therefore, appropriate

levels of respiratory protection and PPE will be required during remediation of contaminated air, liquids, and solids within Air Force sites to ensure worker safety. Levels of respiratory protection and the required clothing for each level are further defined in Section 7 of this Health and Safety Plan.

SECTION 6

EMERGENCY RESPONSE PLAN

All hazardous waste site activities will present a degree of risk to onsite personnel. During routine operations, risk is minimized by establishing good work practices, staying alert, and using proper personal protective equipment (PPE). Unpredictable events such as physical injury, chemical exposure, or fire may occur and must be anticipated. All field team members must participate in Red Cross or equivalent first aid and cardiopulmonary resuscitation (CPR) courses to more effectively handle physical and medical emergencies that may arise in the field. The sections below establish procedures and guidelines for emergencies.

6.1 GUIDELINES FOR PRE-EMERGENCY PLANNING AND TRAINING

Employees must read this health and safety plan, the site specific addendum to this plan, and familiarize themselves with the information in this chapter. Prior to project initiation, the SHSO will conduct a meeting with the field team members to review the provisions of this health and safety plan and to review the emergency response plan. Employees are required to have a copy of the emergency contacts and telephone numbers immediately accessible onsite and know the route to the nearest emergency medical services. The emergency contacts, telephone numbers, and routes to the hospital will be provided in the site-specific health and safety plan addenda prepared for each bioventing site.

6.2 EMERGENCY RECOGNITION AND PREVENTION

Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while onsite.
- A condition is discovered that suggests the existence of a situation more hazardous than anticipated. (e.g. flammable atmospheres, drums encountered)
- Concentrations of combustible vapors reach or exceed 20 percent of the lower explosive limit (LEL).
- A fire or explosion hazard exists.
- Concentrations of organic vapors exceed 1.0 ppm above background air concentrations (based on the PEL for benzene) on a PID.

- A vehicle accident occurs.

Some ways of preventing emergency situations are listed below.

- Site workers must maintain visual contact and should remain close together to assist each other during emergencies. (Use the buddy system.)

- During continual operations, onsite workers act as safety backup to each other. Offsite personnel provide emergency assistance.

- All field crew members should make use of all of their senses to alert themselves to potentially dangerous situations which they should avoid (e.g., presence of strong and irritating or nauseating odors).

- Field crew members will be familiar with the physical characteristics of investigations, including:

  - Wind direction in relation to contamination zones;

  - Accessibility to associates, equipment, and vehicles;

  - Communications;

  - Hot zone (areas of known or suspected contamination) this must be marked off;

  - Site access; and

  - Nearest water sources.

- Personnel and equipment in a work area should be minimized, consistent with effective site operations.

In the event that any member of the field crew experiences any adverse effects or symptoms of exposure while on the scene, or that organic vapors and combustible vapors exceed the action limits (see the site specific addenda), the entire field crew will immediately halt work and act according to the instructions provided by the SHSO.

The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated will result in the evacuation of the field team and reevaluation of the hazard and the level of protection required.

In the event an accident occurs, the site manager is to complete an Accident Report Form. Follow-up action should be taken to correct the situation that caused the accident.

6.3 PERSONNEL ROLES, LINES OF AUTHORITY, AND COMMUNICATION PROCEDURES DURING EMERGENCY

When an emergency occurs, decisive action is required. Rapidly made choices may have far-reaching, long-term consequences. Delays of minutes can create or exacerbate

life-threatening situations. Personnel must be ready to respond to emergency situations immediately. All personnel will know their own responsibilities during an emergency, know who is in charge during an emergency, and the extent of that person's authority. This section outlines personnel roles, lines of authority, and communication procedures during emergencies.

In the event of an emergency situation at the site, the field team leader will assume total control and will be responsible for onsite decision making. The designated alternate for the field team leader will be the site health and safety officer. These individuals have the authority to resolve all disputes about health and safety requirements and precautions. They will also be responsible for coordinating all activities until emergency response teams (ambulance, fire department, etc.) arrive onsite.

The site manager and/or site health and safety officer will ensure that the necessary US Air Force installation personnel, Parsons ES personnel, and agencies are contacted as soon as possible after the emergency occurs. All onsite personnel must know the location of the nearest phone and the location of the emergency phone number list.

6.4 EVACUATION ROUTES AND PROCEDURES, SAFE DISTANCES, AND PLACES OF REFUGE

In the event of emergency conditions, decontaminated employees will evacuate the area as instructed, transport decontaminated injured personnel, or take other measures to ameliorate the situation. Evacuation routes and safe distances will be decided upon and posted by the field team prior to initiating work.

6.5 DECONTAMINATION OF PERSONNEL DURING AN EMERGENCY

Procedures for leaving a contaminated area must be planned and implemented prior to going onsite. Work areas and decontamination procedures will be established based on anticipated site conditions. If a member of the field crew is exposed to chemicals, the emergency procedures outlined below will be followed:

- Another team member (buddy) will assist or remove the individual from the immediate area of contamination to an upwind location.
- Precautions will be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the clothing will be removed if it is safe to do so.
- Administer first aid and transport the victim to the nearest medical facility, if necessary.

If uninjured employees are required to evacuate a contaminated area in an emergency situation, emergency decontamination procedures will be followed. At a minimum these would involve moving into a safe area and removing protective equipment. Care will be taken to minimize contamination of the safe area and personnel. Contaminated clothing will be placed in plastic garbage bags or other suitable containers. Employees will wash or shower as soon as possible.

6.6 EMERGENCY SITE SECURITY AND CONTROL

For this project, the field team leader (or designated representative) must know who is on site and who is in the work area. Personnel access into the work area will be controlled. In an emergency situation, only necessary rescue and response personnel will be allowed into the exclusion zone.

6.7 PROCEDURES FOR EMERGENCY MEDICAL TREATMENT AND FIRST AID

6.7.1 Chemical Exposure

In the event of chemical exposure (skin contact, inhalation, ingestion) the following procedures will be implemented:

- Another team member (buddy) will assist or remove the individual from the immediate area of contamination to an upwind location.
- Precautions will be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the clothing will be removed if it is safe to do so.
- If the chemical has contacted the skin, the skin will be washed with copious amounts of water, preferably under a shower.
- In case of eye contact, an emergency eye wash will be used. Eyes will be washed for at least 15 minutes. Emergency eyewashes will comply with ANSI Z-358.1 and filled with tempered water maintained no cooler than 60°F and no warmer than 95°F. Eyewashes will be capable of delivering 0.4 to 0.8 gallons of water to both eyes for a minimum of 15 minutes. Each jobsite will have at least one emergency eyewash station. Each crew will have, at a minimum, an ANSI-approved personal eyewash suitable for initial eye flushing while the injured person is moved to an emergency eyewash station or medical facility.
- If necessary, the victim will be transported to the nearest hospital or medical center. If necessary, an ambulance will be called to transport the victim.

6.7.2 Personal Injury

In the event of personal injury:

- Field team members trained in first aid can administer treatment to an injured worker.
- The victim will be transported to the nearest hospital or medical center. If necessary, an ambulance will be called to transport the victim.
- The field supervisor is responsible for the completion of the appropriate accident report form.

6.7.3 Fire or Explosion

In the event of fire or explosion, personnel will evacuate the area immediately. Administer necessary first aid to injured employees. Personnel will proceed to a safe area and telephone the emergency support services. Upon contacting the emergency support services, state your name, nature of the hazard (fire, high combustible vapor levels), the location of the incident, and whether there were any physical injuries requiring an ambulance. Do not hang up until the emergency support services has all of the additional information they may require.

SECTION 7

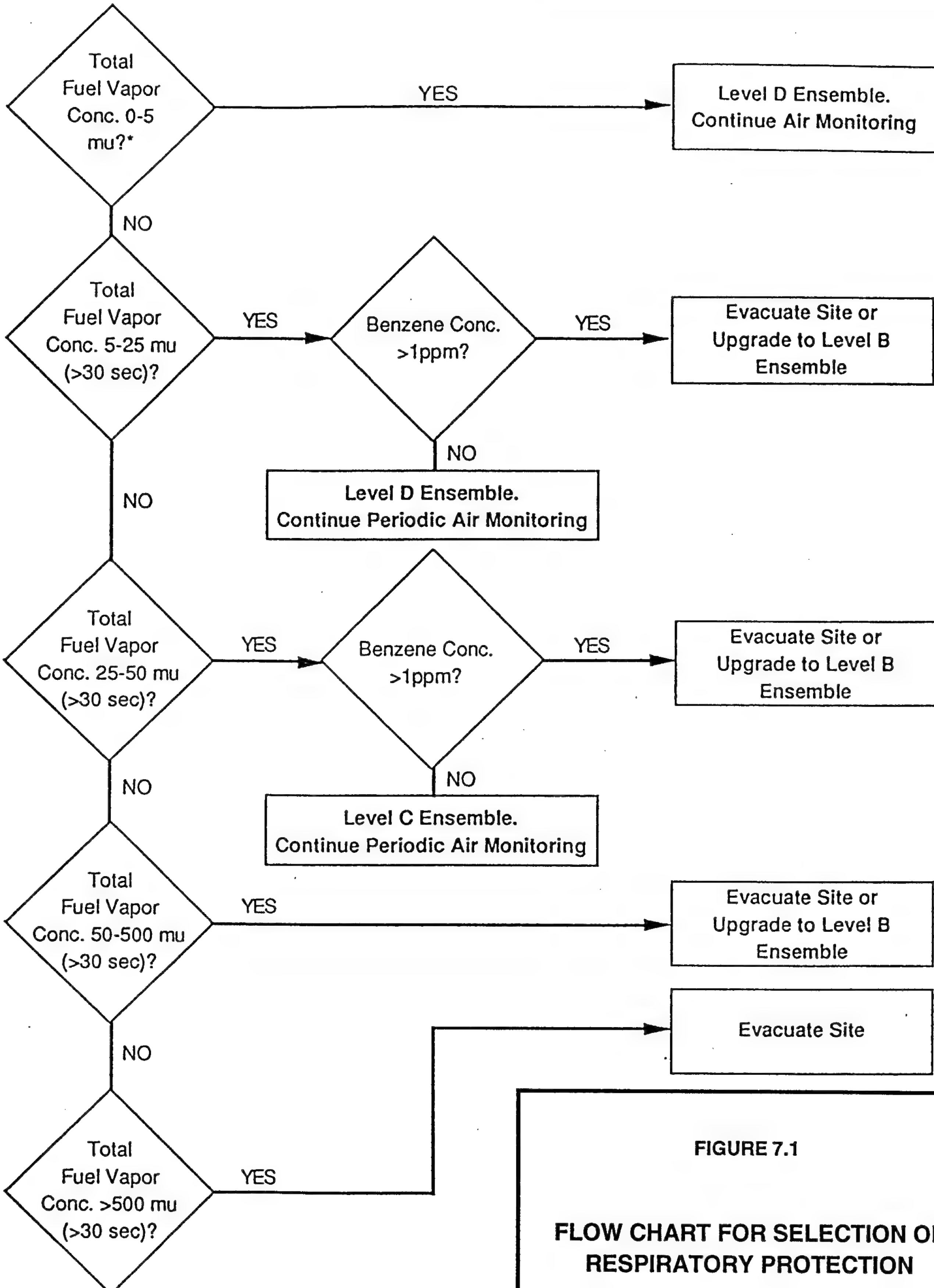
LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

7.1 PERSONAL PROTECTIVE EQUIPMENT

The personal protection level prescribed for the extended bioventing program at U.S. Air Force Installations OSHA Level D with a contingency for the use of OSHA Level C or B as site conditions require. Unless certain compounds are ruled out through use of appropriate air monitoring techniques such as Dräger® tubes, or table sampling pumps, or an onsite gas chromatograph (GC), Level C respiratory protection [air purifying respirator (APR)] cannot be used. Level C protection may only be used on this project when vapors in air are adequately identified and quantified and Level C respirator-use criteria are met. Personal protective equipment (PPE) will be required when handling contaminated samples, working with potentially contaminated materials, during construction or installation of bioventing systems. Figure 7.1 provides direction for selection of respiratory protection. The SHSO must ensure that all field personnel are properly trained in use, maintenance, limitations (including breakthrough time), and disposal of PPE assigned to them in accordance with federal OSHA regulations in 29 CFR 1910.132. Disposable PPE will be used whenever possible to simplify decontamination, to reduce generation of contaminated washwater, and to avoid potential problems with chemical permeation (breakthrough). Single-use PPE (such as Tyvek® will be disposed of whenever personnel go through decontamination. At most, a single item of disposable PPE (including respirator cartridges) will be used for no more than one day and then will be disposed of. Double layers of gloves will be used when personnel are handling contaminated soil or water, or equipment to minimize breakthrough. If personnel note chemical odors on their hands, clothing, or skin after wearing PPE, or develop skin irritation or rashes, consult with the SHSO and decide on alternate actions and/or seek medical attention.

Ambient air monitoring of organic vapors will be performed using photoionization detectors such as an HNu® or Photovac MicroTIP® or colorimetric analysis with Dräger® tubes. Employee exposure monitoring for particulates will be conducted if necessary using portable air sampling pumps. The direct-reading instrumentation will be used to select the appropriate level of personal protection. The criteria to be used for respiration selection are shown in Figure 7.1.

If organic vapor concentrations onsite are in the range of 1 ppm above background, the field team must evacuate the area or use Dräger® tubes or equivalent instruments to identify whether benzene is present. If concentrations of benzene exceed 1 ppm in the breathing zone, the field team must evacuate the area until benzene concentrations drop below the PEL or until Level B respiratory protection can be provided.



* mu = Meter Units

FIGURE 7.1

FLOW CHART FOR SELECTION OF RESPIRATORY PROTECTION

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Extended bioventing site activities at U.S. Air Force Installations will include soil and soil gas sampling, monitoring well installation, and surface and ground water sampling. The required personal protective ensemble for each activity is presented below:

Drilling and Sampling of Soil Borings/Ground Water Well Installation

Mandatory Equipment:
- Leather boots, steel toe and shank
- Hard hats
- Safety glasses
- Vinyl or Latex inner gloves
- Butyl outer gloves/Nitrile Inners
- Ear plugs

Optional Equipment:
- Tyvek® suits
- Saranex® suits or rainsuits
- Outer boot covers
- Respirators equipped with organic/HEPA cartridges

*Vinyl or latex inner gloves must be worn when handling split-spoon samples. If preliminary sample analysis with a photoionization detector indicates potential contamination, butyl gloves will also be worn. Outer boot covers, Saranex® suits, or rainsuits should be worn when potential for liquid contamination exists.

Ground Water Sampling

*Mandatory Equipment:
- Vinyl or latex inner gloves
- Butyl outer gloves

Optional Equipment:
Respirators equipped with:
- Organic vapor/HEPA cartridges
- Saranex® suits or rainsuits
- Chemical goggles
- Rubber safety boots

*At potentially contaminated wells. If there is a potential for contact with contaminated ground water, use rainsuits and gloves, as appropriate.

7.2 EQUIPMENT NEEDS

Each field team will have the following items readily available:

- Copy of program health and safety plan and site-specific addendum and a separate list of emergency contacts;
- First aid kit which includes PPE for bloodborne pathogens;
- Eyewash bottle;

- Paper towels;
- Duct tape;
- Water (for drinking and washing);
- Plastic garbage bags;
- Fire extinguisher; and
- Earplugs.

7.3 EQUIPMENT DISPOSAL

All reusable PPE (such as hardhats and respirators), if contaminated, will be decontaminated in accordance with procedures specified in Section 10 of this health and safety plan. Contaminated single-use PPE (such as Tyvek® suits and protective gloves) will be properly disposed of in drums. The drums will be labeled with the type of material, site number and location, boring/monitoring well identification, date, U.S. Air Force project manger and his/her telephone number.

SECTION 8

FREQUENCY AND TYPES OF AIR MONITORING

Air monitoring will be used to identify and quantify airborne levels of hazardous substances. Periodic monitoring is required during on site activities. The types of monitoring and equipment to be used are as follows:

Type of Equipment	Minimum Calibration Frequency	Parameter(s) to be Measured	Minimum Sampling Frequency	Sampling Locations
Photoionization Detector	1/day	Organic Vapors	• 4/hr or each 5-foot intervals (while disturbing or drilling into soils) • 1/hour when working near soil vapor extraction unit	• Breathing Zone • Soil Borings • Monitoring Wells • Resiration Testing
Sensidyne® or Draeger® Tubes	None (check manufacturer's requirements)	Benzene	• When PID exceeds 1 ppm	• Breathing Zone • Soil Borings • Monitoring Wells
Dosimeter Badges	None	Benzene	• As needed on workers with greatest exposure to contamination	• Breathing Zone

During intrusive operations that disturb site soils, a photoionization detector (such as an HNu®, Photovac TIP®, or MicroTIP®) should be used to measure ambient air concentrations in the worker breathing zone. A concentration of 1 ppm above background in the breathing zone will necessitate evacuation until the area is well ventilated (based on the exposure limit for benzene). If benzene is ruled out then proceed to sample for compounds with the next highest PEL/TLV (action level).

Worker exposure monitoring will be conducted to document any exposures of Parsons ES personnel to organic vapors received on site. Portable air sampling pumps or organic vapor monitoring badges will be used for personal exposure monitoring, if necessary.

The following general protocols will be followed for monitoring with pumps.

- The portable pump will be calibrated to the required flow rate (liters per minute) following specific manufacturer's calibration procedures;
- The pump will be equipped with the appropriate sorbent tube for the particular organic compounds to be monitored (such as charcoal for volatile organics);
- An air monitoring data sheet will be completed which will list pump flow rates, start and stop times, sorbent tube used, etc.;
- The pump will undergo a final flow rate check;
- The laboratory analysis results will be disclosed to the employee(s) monitored; and
- The analysis results will be placed in the employee's permanent medical file for documentation of any exposures received.

An organic vapor monitoring badge will be attached in the worker's breathing zone for an eight hour period, three times over the course of the project and while free product is being sampled. A blank will also be sent with the badges for analysis. These personal dosimeter badges work by means of diffusion so that no pump, calibration or batteries are necessary.

SECTION 9

SITE CONTROL MEASURES

The following site control measures will be followed in order to minimize potential contamination of workers, protect the public from potential site hazards, and to control access to the sites. Site control involves the physical arrangement and control of the operation zones and the methods for removing contaminants from workers and equipment. The first aspect, site organization, is discussed in this section. The second aspect, decontamination, is considered in the next section.

9.1 SITE ORGANIZATION/OPERATION ZONES

Any time respirators are worn, the following operation zones will be established on the site or around a particular site feature (such as the drill rig, or bioventing system).

- Exclusion Zone (Contamination Zone),
- Contamination Reduction Zone, and
- Support Zone.

If protective clothing, such as gloves and/or Tyvek, suits are worn but respirators are not worn (Level D-modified), the field crew will establish a decontamination area to avoid spreading contaminants offsite. The field team leader and/or SHSO will be responsible for establishing the size and distance between zones at the site or around the site feature. Considerable judgment is required to assure safe working distances for each zone are balanced against practical work considerations.

9.1.1 Exclusion Zone (EZ) (Contamination Zone)

The EZ includes the areas where active investigation or cleanup operations take place. Within the EZ, prescribed levels of PPE must be worn by all personnel. The hotline, or EZ boundary, is initially established based upon the presence of actual wastes or apparent spilled material, or through air monitoring, and is placed around all physical indicators of hazardous substances. The hotline may be readjusted based upon subsequent observations and measurements. This boundary should be physically secured and posted or well-defined by physical and geographic boundaries.

Under some circumstances, the EZ may be subdivided into zones based upon environmental measurements or expected onsite work conditions.

9.1.2 Contamination Reduction Zone (CRZ)

Between the EZ and the support zone is the CRZ. This zone provides an area to prevent or reduce the transfer of hazardous materials which may have been picked up by personnel or equipment leaving the exclusion area. All decontamination activities occur in this area. The organization of the CRZ, and the control or decontamination operations, are described in Section 10.

9.1.3 Support Zone

The support zone is the outermost area of the site and is considered a noncontaminated or clean area. The support zone contains the command post for field operations, first aid stations, and other investigation and cleanup support. Normal work clothes are appropriate apparel within this zone; potentially contaminated personnel clothing, equipment, etc., are not permitted.

9.2 SITE SECURITY

Site security is necessary to prevent exposure of unauthorized, unprotected individuals in the work area. The areas immediately surrounding the work area will be clearly marked through use of warning signs, traffic cones, barrier tape, rope, or other suitable means.

Site security will be enforced by the SHSO who will ensure that only authorized personnel are allowed in the work area and that entry personnel have the required level of PPE, are trained under the requirements of 29 CFR 1910.120, and are on a current medical monitoring program.

9.3 SITE COMMUNICATION

Internal site communication is necessary to alert field team members in the EZ and CRZ of emergency conditions, to convey safety information, and to communicate changes or clarification in the work to be performed. For internal site communication, the field team members will use prearranged hand signals (and responses). Radios and/or compressed air horns may also be used for communication.

External site communication is necessary to coordinate emergency response teams and to maintain contact with essential offsite personnel. A telephone will be available for use in external site communication. A list of emergency contact phone numbers will be provided in subsequent addenda.

9.4 SAFE WORK PRACTICES

To ensure a strong safety awareness program during field operations, personnel will have adequate training, this health and safety plan must be communicated to the employees, and standing work orders developed and communicated to the employees. Sample standing orders for personnel entering the CRZ and EZ are as follows:

- No smoking, eating, drinking;

- No matches/lighters in the zone;
- Check in/check out at access control points;
- Use the buddy system;
- Wear appropriate PPE;
- Avoid walking through puddles or stained soil;
- Discovery of unusual or unexpected conditions will result in immediate evaluation and reassessment of site conditions and health and safety practices;
- Conduct safety briefings prior to onsite work;
- Conduct daily/weekly safety meetings as necessary; and
- Take precautions to reduce injuries from heavy equipment and other tools.

The following guidelines will also be followed while working onsite:

- Heavy Equipment - Only qualified operators will be allowed to operate heavy equipment. Subcontractors will be required to use the safe work guidelines included in the OSHA General Industry (29 CFR 1910) and Construction Industry (29 CFR 1926) Standards.
- Electrical Equipment - As outlined in Section 5.2.5.
- Machine Guarding - All machinery onsite will be properly guarded to prevent contact with rotating shafts, blades or gears.
- Illumination - Work areas will be lighted beyond the minimum requirements of 29 CFR 1910.120
- Engineering Controls - In the event that the project requires additional provisions to safeguard the public and onsite personnel.

SECTION 10

DECONTAMINATION PROCEDURES

10.1 PERSONNEL DECONTAMINATION PROCEDURES

An EZ, CRZ, and support zone will be established whenever field personnel are using Level C respiratory protection. Decontamination station layout will be made on a site-specific basis and will be designed to accommodate the particular PPE worn by employees and the types of chemical hazards encountered. Defined site access and egress points will be established and personnel will enter and exit only through these points. As a general rule, persons assisting in the decontamination station may be in one level lower of respiratory protection than required in the work zone.

A guideline for personnel decontamination is presented in Figure 10.1. This procedure may be modified by the SSH if necessary.

If personnel are in Level D-modified protection (no respirator but using protective gloves and/or suits and other equipment), a portable decontamination station will be set up at the site. The decontamination station will include provisions for collecting disposable PPE (e.g., garbage bags); washing boots, gloves, vinyl rain suits (if used), and field instruments and tools; and washing hands, face, and other exposed body parts. Onsite personnel will shower upon return to their hotel or homes at the end of the work day. Refuse from decontamination will be bagged and left onsite for proper disposal.

Decontamination equipment will include:

- Plastic buckets and pails;
- Scrub brushes and long-handle brushes;
- Detergent;
- Containers of water;
- Paper towels;
- Plastic garbage bags;
- Plastic or steel 55-gallon barrels;
- Distilled water; and

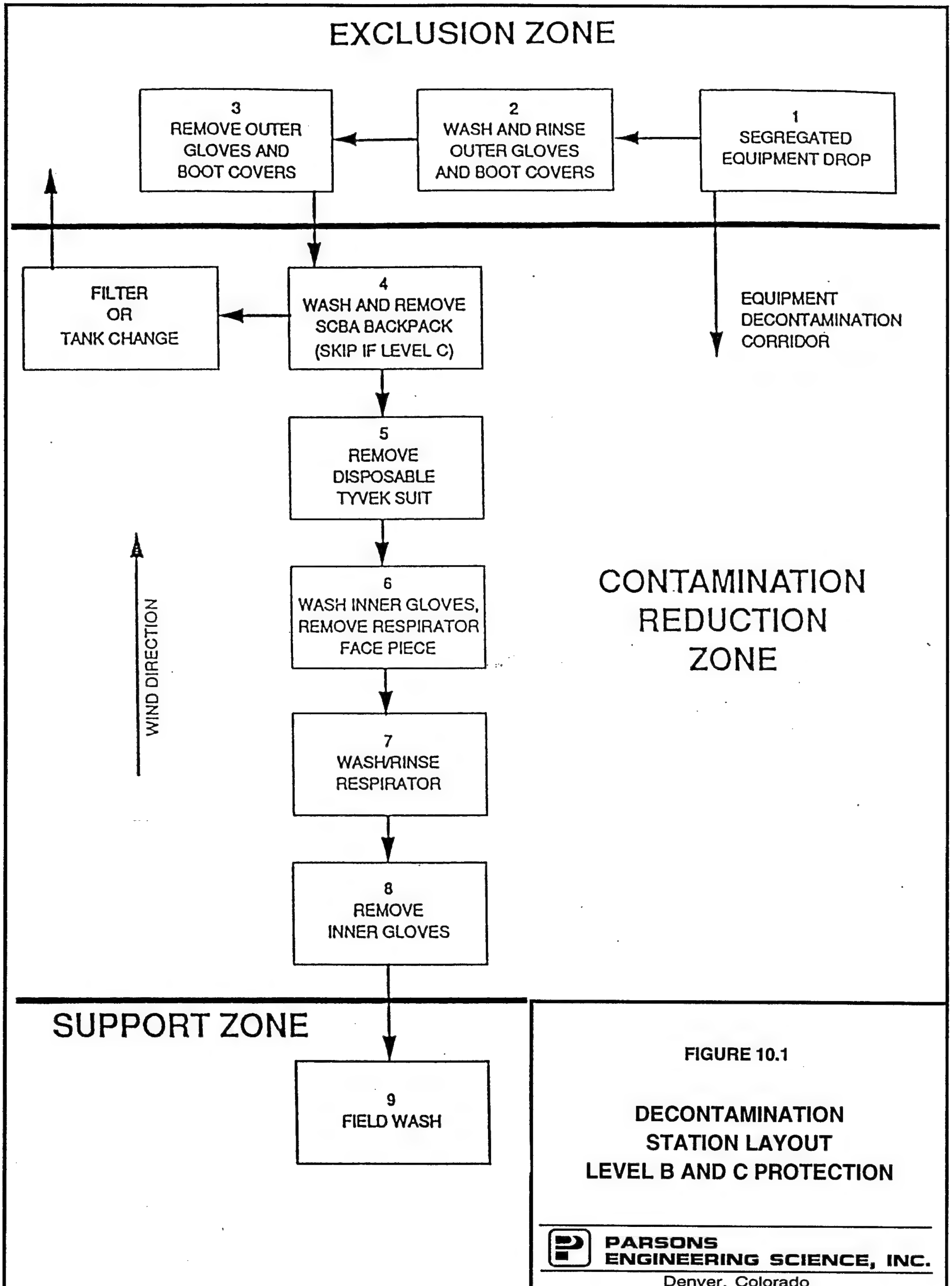


FIGURE 10.1

DECONTAMINATION STATION LAYOUT LEVEL B AND C PROTECTION

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

- An eye wash station.

10.2 DECONTAMINATION OF EQUIPMENT

Decontamination of drilling rigs will be conducted at a location onsite where the rinse water can be collected. High-pressure steam cleaning of drilling rigs will be necessary prior to the start of the drilling operation, between borehole locations, and before the drill rig leaves the project site. All sampling equipment will be decontaminated prior to use, between samples, and between sampling locations. Sampling equipment should be thoroughly washed with detergent, followed by clean water rinse, solvent (methanol) rinse, and a distilled water rinse. Adequate time will be allowed for solvent evaporation.

SECTION 11

AIR MONITORING EQUIPMENT USE AND CALIBRATION PROCEDURES

11.1 PHOTOVAC TIP AIR ANALYZER

To use the Photovac TIP® press the power switch, unlock ZERO and SPAN controls by turning locking rings clockwise. Set span control to 5, lock span control by turning locking ring counter-clockwise. Allow TIP® to sample clean air. Adjust zero control until display reads 0.00. Lock zero control by turning locking ring counterclockwise observe sample concentration changes. Turn TIP® off.

The TIP® is used as a direct-reading instrument in conjunction with the span gas kit. In order to calibrate your TIP® press the power switch, unlock the zero and span controls by turning locking rings clockwise. Set span control to 5. Allow TIP® to sample clean air. Adjust zero control until display reads 0.00. Connect bag of span gas to the TIP® inlet. Adjust span control until display indicates the span gas concentration (usually 100 ppm). Disconnect span gas bag. Sample clean air again and readjust zero control until displays reads 0.00. Lock zero control in. Sample span gas again, and readjust span control until display indicates the span gas concentration. Lock span control in. Observe sample concentrations. The concentration of total ionizables is displayed in span gas equivalent units. Turn TIP® off.

11.2 HNu® PHOTOIONIZATION DETECTOR

To use the HNu® connect the probe to the instrument by matching the alignment slot in the probe connector to the key in the 12-pin connector on the control panel, twist the probe connector until a distinct snap and lock is felt. Turn the function switch to battery check position. The needle should read within or above the green battery arc on the scale plate. If the needle is in the lower position of the battery arc, the instrument should be recharged before use. If the red light comes on, the battery should be recharged. Next, turn the functions switch to the on position, and the instrument is ready to take direct air readings.

11.3 TRACETECHTOR® TOTAL VOLATILES ANALYZER

The Tracetechtor® is used for measuring total volatile hydrocarbon gas levels. The ON/OFF switch is located on the front of the case. Once the unit is turned on, wait a few seconds for the readings to stabilize. Check the battery charge and the alarms before using the instrument.

To calibrate the instrument with span gas, attach the flow regulator to the calibration gas cylinder. Fill a 3-liter Tedlar bag with calibration gas. Connect the instrument to the Tedlar bag using Tygon tubing and wait for the readings to stabilize. Using a small jeweler's screwdriver, adjust the span gas pot on the side of the instrument to obtain a steady reading which corresponds with the calibration gas concentration. Remove the calibration lines and let the instrument run for a full minute to flush out any excess span gas. Check readings; the combustible sensor should now be reading zero in fresh air.

11.4 SENSIDYNE, OR DRÄGER®, COLORIMETRIC GAS ANALYSIS TUBES (BENZENE SPECIFIC)

Dräger® tubes can be used to give an instantaneous reading of various organic compounds. Their aim is to determine very small concentrations of a compound in the shortest amount of time. To sample with a Dräger® tube use the Dräger® or Sensidyne® bellows pump and select the appropriate tube (for example, a tube marked benzene to look for benzene). Break off both ends on the pump's break-off plate. Insert the tube into the pump head (the tube should be inserted with the arrow pointing towards the pump). There is a given number of suction strokes for each tube/compound. Each box of tubes will have instructions for how many suction strokes are required for that compound.

APPENDIX A

EMERGENCY CONTACTS

APPENDIX A

EMERGENCY CONTACTS

In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from a list similar to this which will be prepared in the health and safety plan addenda. For emergency situations, telephone or radio contact should be made with the site point of contact or site emergency personnel who will then contact the appropriate response teams.

Contingency Contacts	Phone Number
Nearest phone located at the work site	____________
Base Fire Department	____________
Site Contact	____________
Site Medical Services	____________
Site Emergency Number	____________
Security Police	____________
Medical Emergency	
Hospital Name	____________
Hospital Phone Number	____________
Ambulance Service (Also Police)	____________
Airlift helicopter	____________

Directions or Map to the Hospital

ES Contacts	
ES Project Manager Doug Downey	(303) 831-8100 (w) (303) 670-0512 (h)
ES Health and Safety Manager Timothy Mustard	(303) 831-8100 (w) (303) 450-9778 (h)
Corporate Health and Safety Manager Edward Grunwald	(404) 325-0770 (w)

APPENDIX B

PROJECT HEALTH AND SAFETY FORMS

APPENDIX B

SITE/BASE SPECIFIC TRAINING RECORD

On this date ______________ the following individuals were provided site specific training in accordance with OSHA regulations contained in 29 CFR 1910.120 (e). This individuals have also read and are familiar with the contents of the site specific health and safety plan.

Name (print) Employee No. Signature

1.____

2.____

3.____

4.____

5.____

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

Instructions: This form is to be completed by each person to work on the subject project work site and returned to the safety manager.

I have read and agree to abide by the contents of the Health and Safety Plan for the following project:

____

____

____
Signed

____
Date

RETURN TO:

Office Health and
Safety Representative
Engineering-Science, Inc.
1700 Broadway, Suite 900
Denver, CO 80290

SCBA LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	SCBA#	Satisfactory (Yes/No)	Check-Out Initials	Date Cleaned

SCBA Performance Comments:

Project H&S Officer or ES Project Manager — Date

Return to Office Health and Safety Representative at the completion of field activities.

AIR PURIFYING
RESPIRATOR LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	Cleaned and Inspected Prior To Use (Initials)	Cartridges Changed Prior to Use (Yes, No, N/A)	Total Hours on Cartridge

Project H&S Officer
or
ES Project Manager

Date

Return to the Office Health and Safety Representative
at the Completion of field activities.

A7-15-19

SAR

RESPIRATOR LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	SAR#	Satisfactory (Yes/No)	Check-Out Initials	Date Cleaned

SAR Performance Comments:

Project H&S Officer or ES Project Manager — Date

Return to Office Health and Safety Representative at the completion of field activities.

ST-6-83

PARSONS ENGINEERING SCIENCE COMPANIES

ACCIDENT REPORT FORM

Project: ______________________

EMPLOYER

1. Name: ______________________
2. Mail Address: ______________________
   (No. and Street) (City or Town) (State and Zip)
3. Location (if different from mail address: ______________________

____

INJURED OR ILL EMPLOYEE

4. Name: ______________________ Social Security No.: ____________
   (first) (middle) (last)
5. Home Address: ______________________
   (No. and Street) (City or Town) (State and Zip)
6. Age: ______ 7. Sex: male ( ) female ( )
8. Occupation: ______________________
   (specific job title, not the specific activity employee was performing at time of injury)
9. Department: ______________________
   (enter name of department in which injured person is employed, even though they may have been temporarily working in another department at the time of injury)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident of exposure: ______________________
    (No. and Street) (City or Town) (State and Zip)
11. Was place of accident or exposure on employer's premises? Yes ( ) No ( )
12. What was the employee doing when injured? ______________________
    (be specific--was employee using tools or equipment
    ____
    or handling material?)
    ____
13. How did the accident occur? ______________________
    (describe fully the events that resulted in the injury or occupational illness.
    ____
    Tell what happened and how. Name objects and substances involved. Give details on all factors that led to
    ____
    accident. Use separate sheet for additional space).
14. Time of accident: ______________

15. ES WITNESS TO ACCIDENT ______________________________
(Name) (Affiliation) (Phone No.)

____
(Name) (Affiliation) (Phone No.)

____
(Name) (Affiliation) (Phone No.)

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

16. Describe injury or illness in detail; indicate part of body affected:

____

____

17. Name the object or substance that directly injured the employee. (for example, object that struck employee; the vapor or poison inhaled or swallowed; the chemical or radiation that irritated the skin; or in cases of strains, hernias, etc., the object the employee was lifting, pulling, etc.).

____

____

18. Date of injury or initial diagnosis of occupational illness: ______________________
(date)

19. Did the accident result in employee fatality? Yes ( ) No ( )

20. Number of lost days ____/restricted workdays ____ resulting from injury or illness?

OTHER

21. Name and address of physician:______________________________
(No. and Street) (City or Town) (State and Zip)

22. If hospitalized, name and address:______________________________
(No. and Street) (City or Town) (State and Zip)

Date of report: ____________ Prepared by:______________________

Official position:______________________

"NEAR MISS" INCIDENT INVESTIGATION REPORT FORM

1) Project name and number:________________________________

2) "Near miss" location:________________________________

3) Incident date and time:________________________________

4) Personnel present (optional):________________________________

5) Describe incident:________________________________

6) What action or condition contributed to incident?________________

7) What action was taken or suggested to prevent reoccurrence?____________

8) Comments________________________________

9) Date of report____________ Prepared by________________

10) Office health and safety representative review:

____________________ ____________________

Signature Date

022/OH/43/66.WW6

ENGINEERING-SCIENCE, INC.

FIELD EXPERIENCE

DOCUMENTATION FORM

OSHA requires (29CFR1910.120(e)) that personnel involved in hazardous waste operations have 40-hours of initial training and a minimum of three days field experience working under the direction of a trained and experienced supervisor. This form serves to document the three days of additional field training/experience.

Employee Name:____

Employee Number (or Social Security No.):______________________

Project Name(s):____

Project Number(s):______________________________________

Dates of Field Training:__________________________________

Summary of Activities Performed:____________________________

____

____

Levels of Respiratory Protection Used:__________________________

____

Comments:

Field Supervisor Signature:________________________________

Date:____

Return this form to the Office Health and Safety Representative

SITE-SPECIFIC ADDENDUM TO THE EXTENDED BIOVENTING PROGRAM HEALTH AND SAFETY PLAN

FOR THE

EXTENDED BIOVENTING SYSTEM INSTALLATIONS AT

SWMU 55 (SITE FT-03) AND

SITE SS-41 (FORMER BLDG. 93 FUEL PUMPING STATION)

CHARLESTON AFB, SOUTH CAROLINA

February 1997

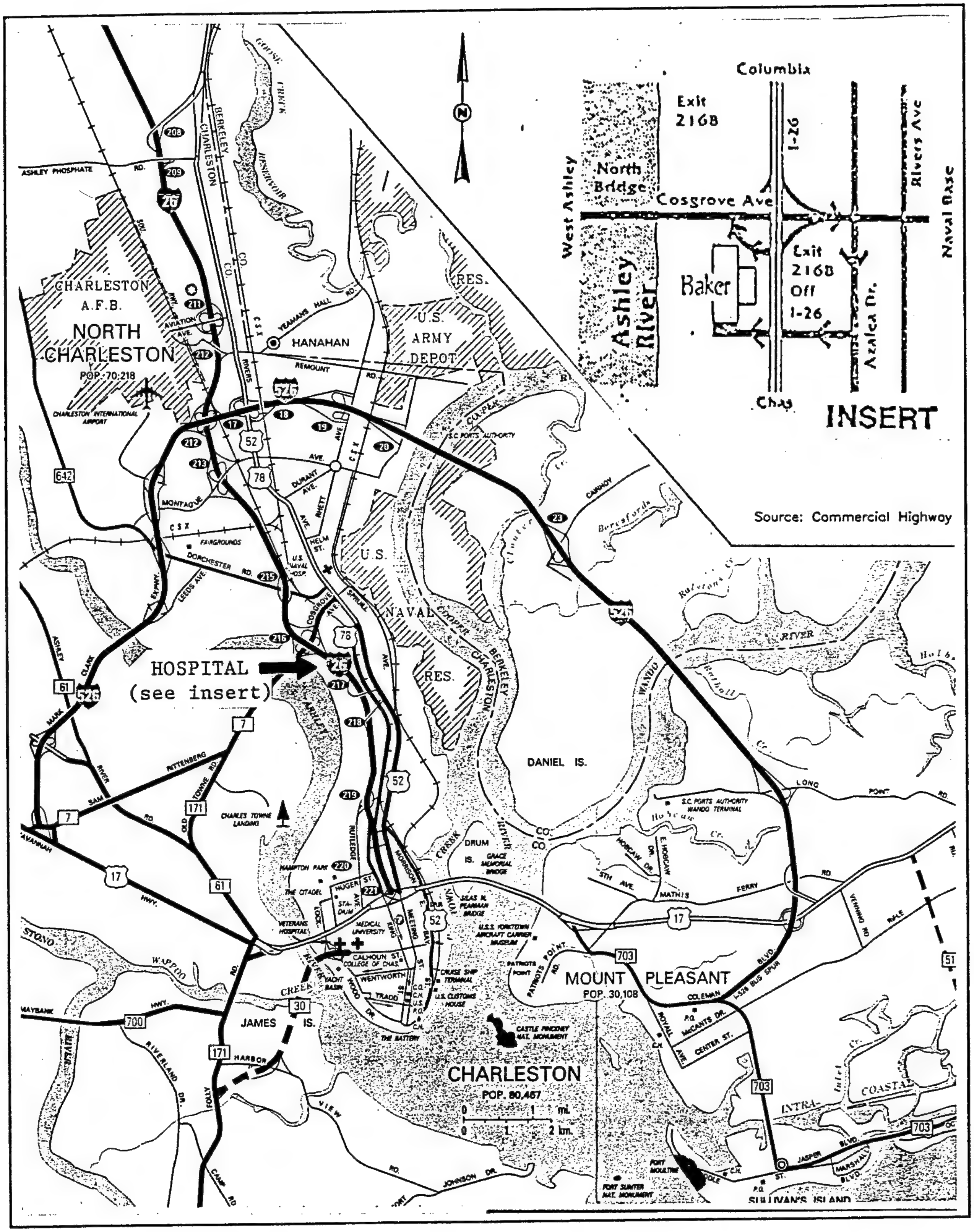
Prepared by:

PARSONS ENGINEERING SCIENCE, INC.
One Harrison Park, Suite 210
401 Harrison Oaks Boulevard
Cary, North Carolina 27513

Reviewed and Approved By:

	Name	Date
Project Site Manager	Grant Watkins	4/7/97
Office H & S Representative	Jefferson B Prather	4/17/97

Figure 1: Directions From Sites To Off-Base Hospital (Sites FT-03 and SS-41)



EMERGENCY CONTACTS

In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from the list below. For emergency situations, telephone or radio contact should be made with the site point of contact or site emergency personnel who will then contact the appropriate response teams. The nearest medical facility for non-life threatening injuries is the base medical clinic. Life-threatening injuries should be transported to Baker Hospital immediately.

Contingency Contacts	Phone Number
Nearest phone located at the work site	(803) 566-4978
Base Fire Department	(803) 566-3117 (or 3113)
Site Contact (Keith Thompson/Al Urrutia)	(803) 566-2696/4978
Site Medical Services	(803) 566-4109 (or 2802)
Local Police	3600 (base phone)
Security Police	(803) 566-3596

Medical Emergency	
Emergency Number	911
Closest Off-Base Hospital Name	Baker Hospital
Hospital Phone Number	(803) 744-2110
Hospital Address	2750 Speissegger Drive
	North Charleston, SC
	29405
Time of Travel from Site	12 minutes
Map to Hospital (see next page)	

Route to Hospital:

Site FT-03: Turn right out of site onto South Aviation Avenue. Turn right on Remount Rd, then turn left to enter the on-ramp for I-26 East bound. Take I-26 East toward Charleston. Exit I-26 at Cosgrove Avenue West (exit 216B), stay in right lane. Turn right on Azalea Drive. Go under interstate highway, hospital is on the right on Speissegger Drive.

Site SS-41: Depart the flightline area to the north along Taxiway 4 to Arthur Drive. Depart base on Arthur Drive via the back gate, where it turns into Airport Road. Follow Airport Road around north end of the airfield, turn left on East Aviation at stop light (2nd intersection). After 1/4 mile, take the I-26 East bound entrance ramp. Take I-26 East toward Charleston. Exit I-26 at Cosgrove Avenue West (exit 216B), stay in right lane. Turn right on Azalea Drive. Go under interstate highway, hospital is on the right on Speissegger Drive. (Alternate route is to exit the main base gate and turn left on Dorchester Rd. Dorchester Road intersects I-26 E after 4 miles).

Parsons ES Contacts

Parsons ES Project Site Manager Grant Watkins. P.G.	(919) 677-0080 (w) (919) 467-8314 (h)
Parsons ES Project Manager John Ratz, P.E.	(303) 831-8100 (w) (303) 733-5582 (h)
Parsons ES Office Health and Safety Rep. Jeff Prather, C.I.H., P.E.	(919) 677-0080 (w) (919) 967-2568 (h)
Parsons ES Program Health and Safety Manager Tim Mustard, C.I.H.	(303) 831-8100 (w) (303) 450-9778 (h)
Corporate Health and Safety Manager Edward Grunwald, C.I.H.	(404) 325-0770 (w)

SECTION 1

PURPOSE AND POLICY

Parsons Engineering Science, Inc. (Parsons ES) has prepared this site-specific health and safety plan (HSP) as an addendum to the existing program HSP entitled *Health and Safety Plan For Extended Bioventing* (Parsons ES, 1995). The program HSP was developed for remediation monitoring and for designing, installing and operating full-scale bioventing systems at numerous U.S. Air Force sites contaminated with petroleum hydrocarbons (AFCEE contract F1624-92-D-8036, Delivery Order 17). The purpose of this site-specific plan addendum is to establish personnel protection standards and mandatory safety practices for the installation/construction and monitoring of these systems at Charleston AFB, South Carolina, specifically Site FT-03 (SWMU 55) and Site SS-41 (former building 93 fuel pumping station). This HSP also provides for contingencies that may arise during field operations. All Parsons ES personnel who engage in field activities will be familiar with this site-specific HSP and with the program HSP and comply with the requirements of both plans.

This site-specific addendum plan provides guidance for general operations at the expanded bioventing sites at Charleston AFB. Site-specific information has been provided in this plan to address mandatory requirements specific to these sites. Included or referenced in this addendum are the scope of work, site-specific descriptions and history, project team organization, hazard evaluation of known or suspected chemicals, physical hazards, and emergency response procedures and information.

The provisions of the plan are mandatory for all on-site personnel. All Parsons ES personnel will abide by the program HSP and this addendum HSP. Any supplemental plans used by subcontractors shall at least conform to these plans. All personnel who engage in project activities must be familiar with this site-specific HSP and with the program HSP and comply with their requirements.

A project description and scope of work summary for the project sites are provided in Section 2. Section 3 presents the program team organization, personnel responsibilities, and lines of authority. Section 4 presents a safety and health risk analysis. Section 5 contains the site-specific employee training and medical monitoring requirements.

SECTION 2

SITE DESCRIPTIONS AND SITE-SPECIFIC SCOPE OF WORK

2.1 SITE DESCRIPTIONS AND HISTORY

2.1.1 Site FT-03 (SWMU 55)

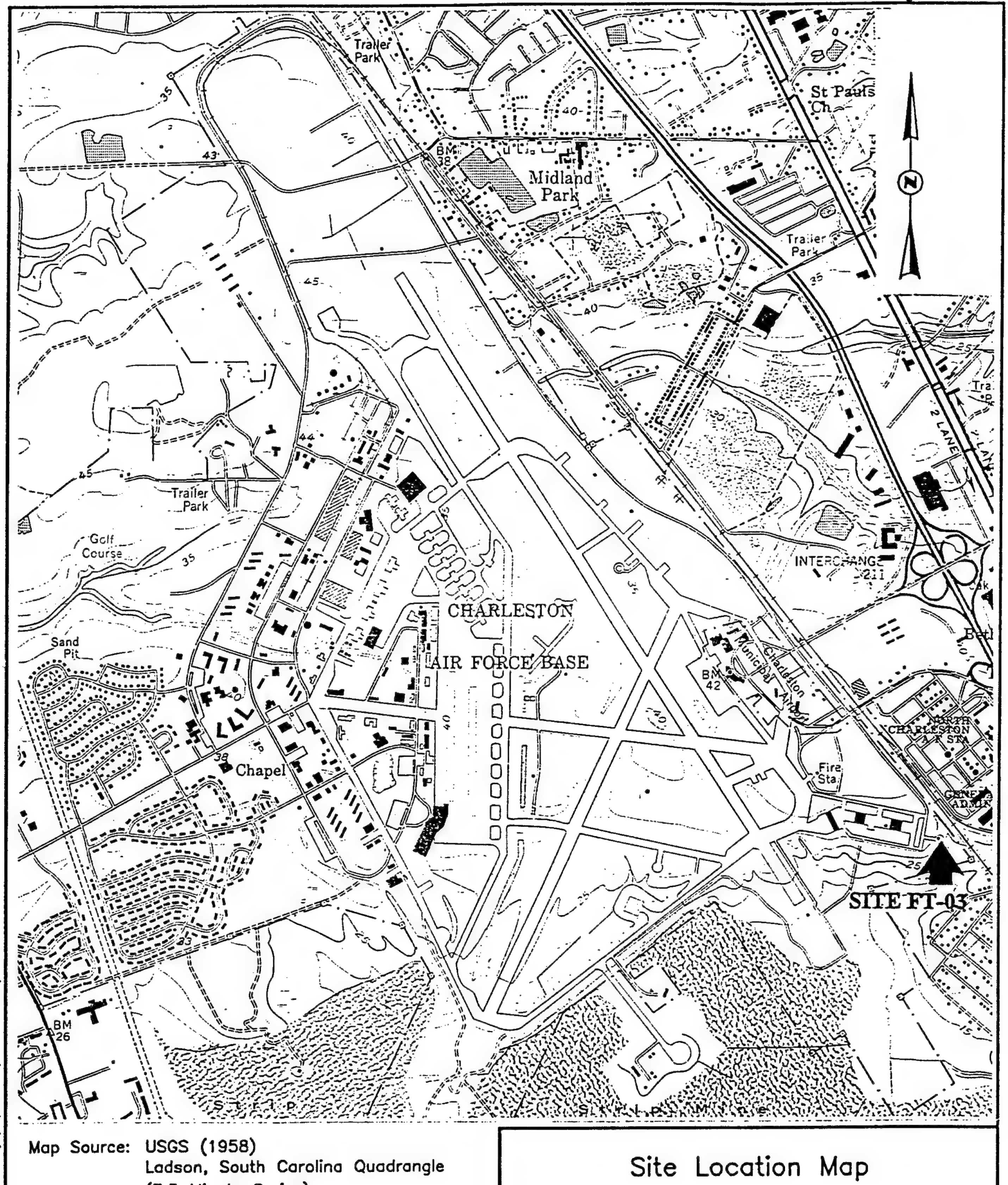
Site FT-03 (Charleston AFB Fire Protection Training Area No. 3), also known as SWMU 55, is approximately 2 acres in size and is located east of Airport Road at the northeast corner of the Base. The site is located on a noncontiguous part of the base and therefore is not secured to entry and exit. The site borders the Base property boundary and is about 1,500 feet from off-Base houses. The site is fenced and is surrounded on three sides by woods and on one side by South Aviation Avenue. A small, intermittent stream channel is located on the north and east sides of the site (Versar, 1992). Figure 2.1 shows the location of Site FT-03 with respect to the Base.

Site FT-03 was operated as a Base fire protection and training exercise area from about 1970 to the early 1980s. The former fire training area exists in the form of a circular pit constructed with an earthen berm and a limestone base. A large steel storage tank, used in the training exercises to simulate an aircraft, remains in the pit. According to base personnel, approximately 300 gallons of JP-4 jet fuel were used to fuel the fire during each training exercise. An average of two training exercises were conducted each month. It is probable that some other industrial flammable wastes may have been burned in the pit. Dry chemicals and various foams were also applied as firefighting agents (Versar, 1992). Soils and groundwater at the site are contaminated with various volatile organic compounds (VOCs), including halogenated VOCs, semi-volatile organic compounds (SVOCs), and various metals.

2.1.2 Site SS-41 (Former Building 93 Fuel Pumping Station)

Site SS-41 includes a large portion of the base fuel hydrant system. The portion of Site SS-41 specific to this HSP was previously known as Building 93-Flightline Fuel Pump House #3 prior to its demolition. The fuel pump station was part of the aircraft apron/taxiway fuel distribution system that receives aircraft fuels from bulk storage (via pipelines) on another part of the base and dispenses the fuel to fueling stations around the aircraft apron. The flightline fuel pump house (former Building 93) was a metal canopy that partially covered the piping manifolds and fuel tanks. The Building 93 pumphouse fuel distribution system consisted of six 50,000-gallon underground storage tanks (USTs), influent and effluent fuel filters, five oil/water separators, underground pipelines and piping manifolds, fuel pumps, and two small USTs for overflow and waste liquid collection and storage. Base personnel report that JP-4 jet fuel was the primary fuel distributed by this facility when it was operated. An active primary fuel line that transfers JP-8 jet fuel remains in operation beneath the site. The fuel pump house system was located on the north side of the aircraft maintenance apron adjacent to apron access Taxiway #4. A large drainage ditch is located between the facility and Taxiway #4. Figure 2.2 shows the former location of the Building 93 fuel pumping station with respect to the base.

Figure 2.1



Map Source: USGS (1958)
Ladson, South Carolina Quadrangle
(7.5 Minute Series)

2000' 1000' 0 2000'

Approximate Scale in Feet

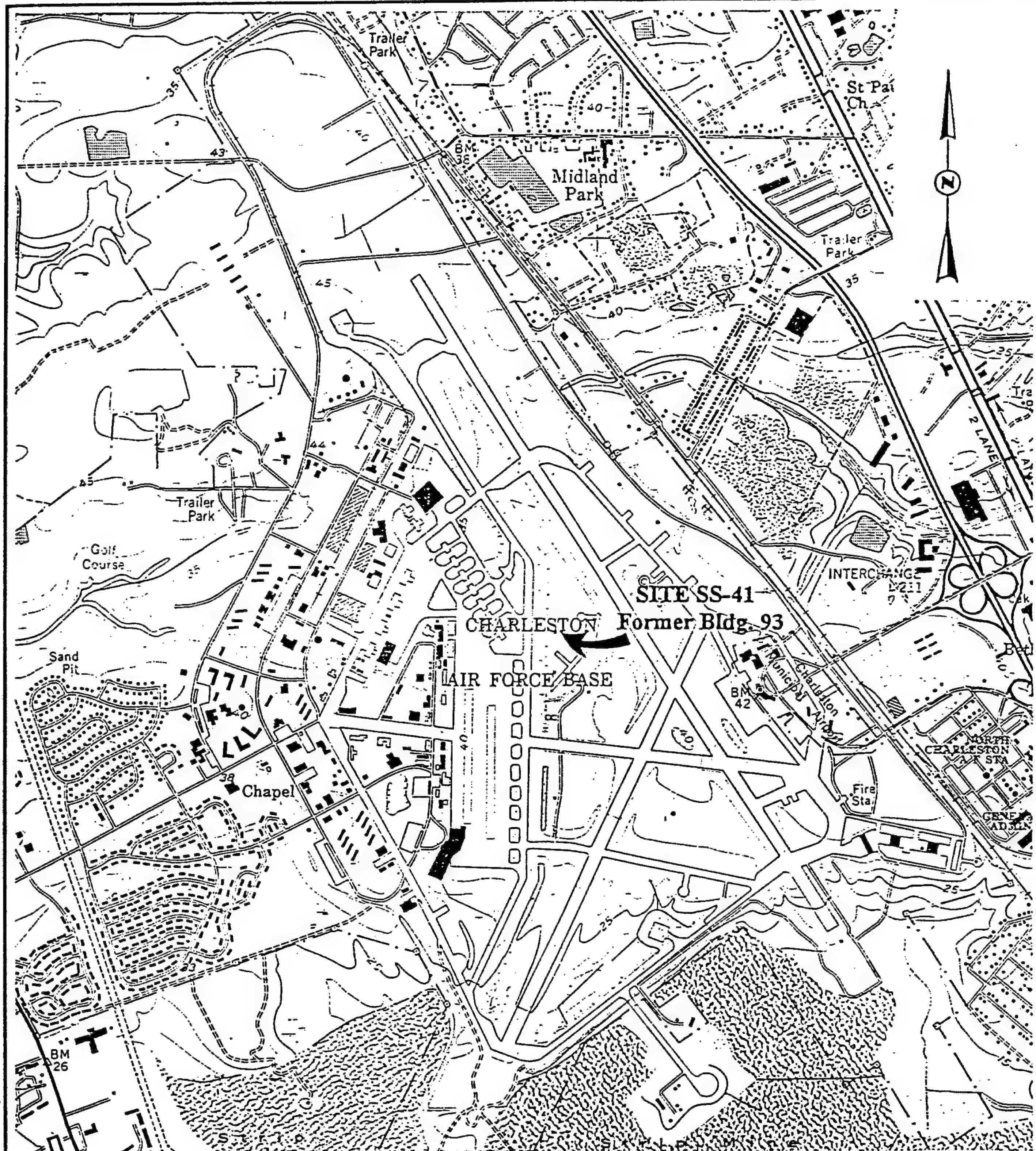
Site Location Map

Site FT–03
Fire Training Area No. 3
Charleston AFB, South Carolina

PARSONS ENGINEERING SCIENCE, INC.

726876/28142/72687609.dwg / ps:1=1 / 7-11-96 / PDA

Figure 2.2



Map Source: USGS (1958)
Ladson, South Carolina Quadrangle
(7.5 Minute Series)

2000' 1000' 0 2000'

Approximate Scale in Feet

Site Location Map

Site SS-41
Bldg. 93 Fuel Pumping Station
Charleston AFB, South Carolina

PARSONS ENGINEERING SCIENCE, INC.

726876/28242/72687604.dwg / ps:1=1 / 7-9-96 / PDA

2.2 PROJECT DESCRIPTIONS AND SCOPES OF WORK

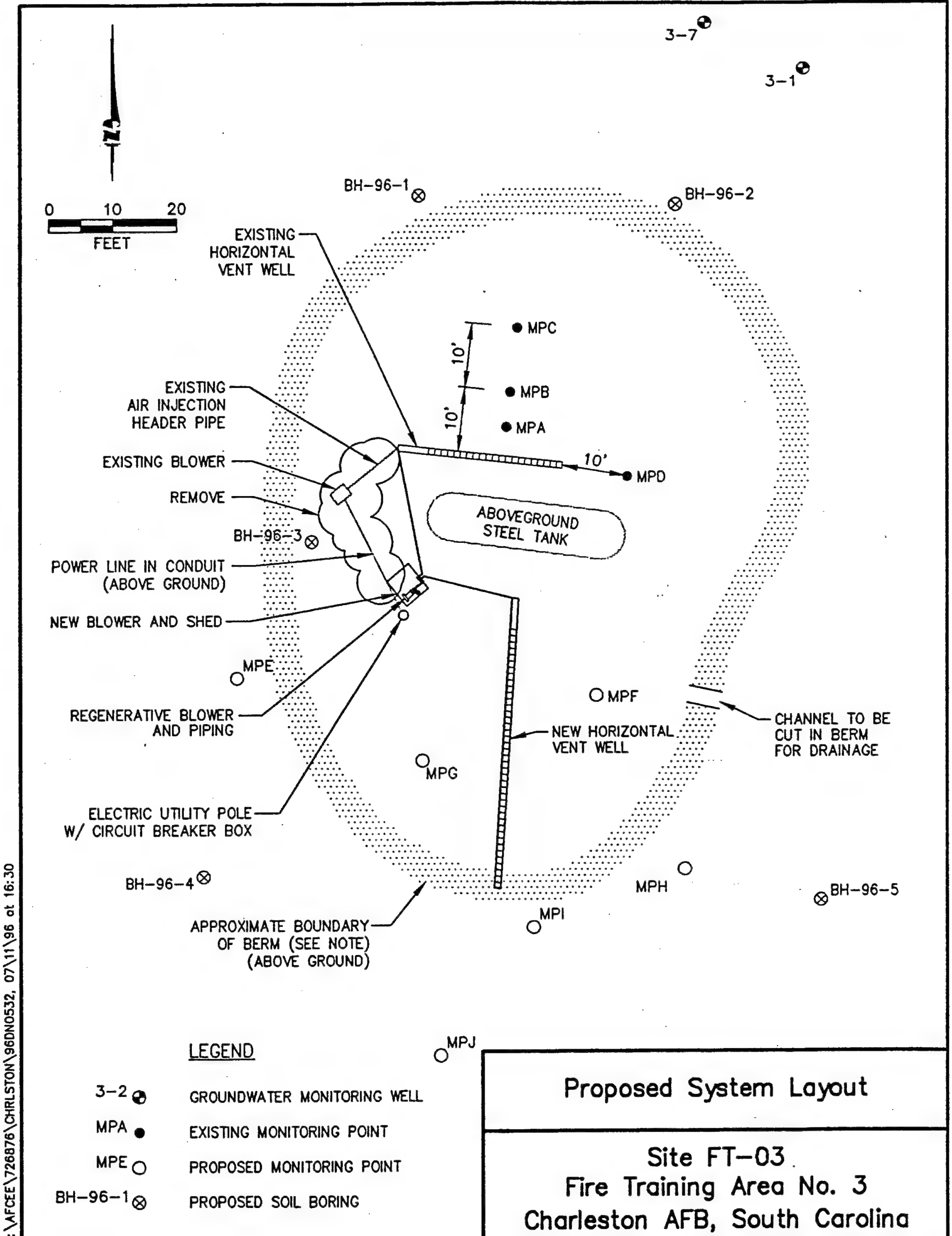
2.2.1 Site FT-03

The objective of the project is to install and operate an expanded bioventing system for *in situ* treatment of fuel-contaminated soils at the site. A pilot-scale bioventing system is currently operating at the site and will be retrofitted as part of the expanded system. The scope of work for this project includes construction and installation of the bioventing system, and operation, monitoring and maintenance of the system for one year. This project will include the following field activities: 1) installation of five or six vapor monitoring points; 2) drilling and soil sampling; 3) soil gas sampling; 4) excavation of a shallow trench/air injection well; 5) construction and wiring of mechanical/electrical components of a bioventing blower system; 6) demolition of the existing pilot-scale system; 7) maintenance of the full-scale system; and 8) periodic sampling and monitoring of soil and soil vapors at the site. Figure 2.3 shows the locations of the proposed vent well trench, monitoring points, and blower systems.

2.2.2 Site SS-41 (Building 93 Fuel Pump Station)

The basic scope of services to be provided at Site SS-41 are the same as those for Site FT-03. The objective of the project is to install and operate an expanded bioventing system for *in situ* treatment of fuel-contaminated soils at the site. A pilot-scale bioventing system is currently operating at the site and will be retrofitted as part of the expanded system. The scope of work for this project includes construction and installation of the bioventing system, and operation, monitoring and maintenance of the system for one year. This project will include the following field activities: 1) installation of nine or ten vapor monitoring points; 2) drilling and soil sampling; 3) soil gas sampling; 4) drilling and installation of up to ten air injection wells; 5) construction, piping, trenching and wiring of mechanical/electrical components of a bioventing blower system; 6) demolition of the existing pilot-scale system; 7) maintenance of the full-scale system; and 8) periodic sampling and monitoring of soil and soil vapors at the site. Figure 2.4 shows the locations of the proposed air injection vent wells, monitoring points, and blower systems.

Figure 2.3

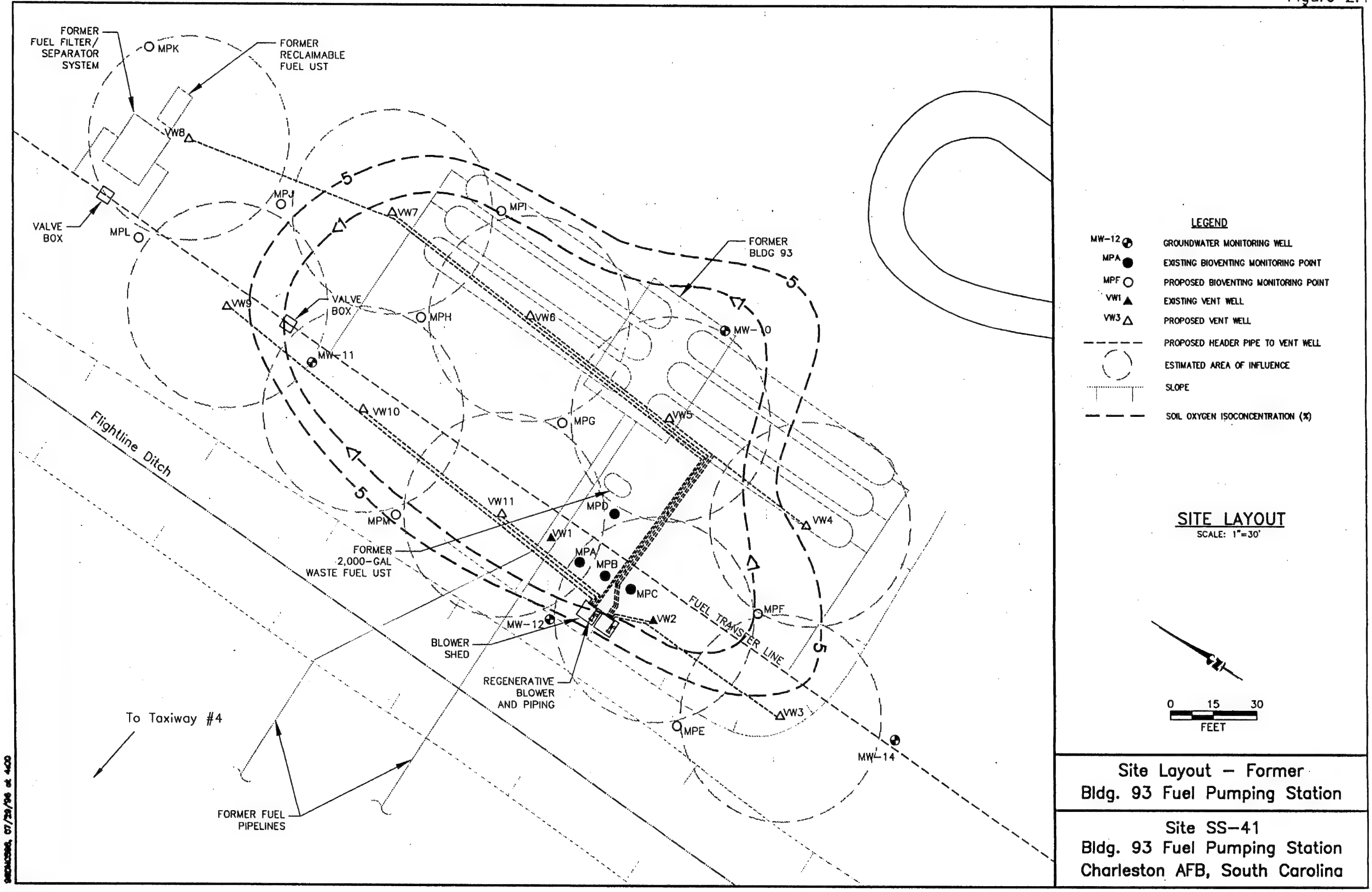


Proposed System Layout

Site FT-03
Fire Training Area No. 3
Charleston AFB, South Carolina

PARSONS ENGINEERING SCIENCE, INC.

Figure 2.4



Site Layout – Former Bldg. 93 Fuel Pumping Station

Site SS-41
Bldg. 93 Fuel Pumping Station
Charleston AFB, South Carolina

PARSONS ENGINEERING SCIENCE

SECTION 3

PROGRAM TEAM ORGANIZATION CHARLESTON AFB EXPANDED BIOVENTING SITES

The Parsons ES team assigned to the Charleston AFB expanded bioventing program and their responsibilities, and lines of authority are outlined below.

Name	Task Assigned
Mr. John Ratz	Project Manager
Mr. Grant Watkins	Site Manager
Mr. Tim Mustard	Program Health and Safety Manager
Mr. Grant Watkins	Site Health and Safety Officer
Mr. Don Malone	Alternate Site Health and Safety Officer
Mr. Keith Thompson	Site Contact Charleston AFB
Mr. Al Urrutia	Alternate Site Contact - Charleston AFB

The site manager is responsible for the overall conduct of the project, including enforcing the requirements of the project health and safety plan. The program health and safety manager will be responsible for updating and revising the project health and safety plan, as necessary. He will arrange for periodic field audits to ensure that the provisions of the health and safety plan are being enforced. These audits will be conducted to verify compliance with the corporate health and safety program and applicable regulations.

The site manager, or an assigned alternate, will supervise construction and installation of the bioventing systems and will serve as the site health and safety officer (SHSO). He is responsible for assuring that the day-to-day field activities are performed in conformance with the site-specific HSP and the program HSP. The site health and safety officer has the authority to stop work on the site if actions or conditions are deemed unsafe or not in conformance with the HSPs.

All field team members and subcontractors are responsible for reading and conforming to the project health and safety plan. All Parsons ES team members will sign the statement found in Appendix B of the Program HSP stating they have read the HSPs, are familiar with their contents and have received training in accordance with OSHA regulation 29 CFR 1910.120(e). No employee will perform a project activity that he or she believes may endanger his or her health and safety or the health and safety of others.

SECTION 4

SAFETY AND HEALTH HAZARD EVALUATION

4.1 CHEMICAL HAZARDS

4.1.1 Site FT-03 Contaminants

The primary contaminants at Charleston AFB Site FT-03 are hydrocarbons originating from jet fuel and other flammable wastes, which have been detected in the soils and groundwater at depths ranging from ground surface to about 30 feet bgs. Total Recoverable Petroleum Hydrocarbons (TRPH) maximum concentrations of 7,770 milligrams per kilogram (mg/kg) have been detected in the soils at a depth of 2 to 3 feet on the north end of the fire pit berm. Shallow sediment samples have also contained TRPH concentrations of 3,310 mg/kg. Volatile organic compounds benzene, toluene, ethylbenzene, and total xylenes (BTEX) were detected in both soils and groundwater at the site. Several chlorinated solvents have also been detected in both soils and groundwater. Lead (dissolved and total) has also been detected in groundwater at the site.

Surface soil samples were collected and analyzed at this site for a combination of the following: volatiles, semivolatiles, TRPH, pesticides, polychlorinated biphenyls (PCBs), and inorganic constituents. Minimal SVOCs were detected in the surface soils. One sample contained elevated concentrations of lead (79.5 mg/kg) and chromium (241 mg/kg).

Seven subsurface soil samples (>2 feet deep) also were collected during a 1992 RFI investigation. Samples were analyzed for a combination of VOCs, SVOCs, TRPH, pesticides, PCB, and inorganics constituents. BTEX and other VOC concentrations were generally low. The highest reported concentrations were 0.005 mg/kg (benzene), 0.004 mg/kg (ethylbenzene), 0.013 mg/kg (total xylenes), 0.012 mg/kg (methylene chloride), 0.014 mg/kg (tetrachloroethene), and 0.004 mg/kg (trichloroethene). The highest reported chromium and lead concentrations in subsurface soil were 19.3 mg/kg and 52.2 mg/kg, respectively.

Six groundwater samples were collected during the 1992 RFI investigation and seven groundwater samples were collected during a subsequent 1994 sampling event. Concentrations of BTEX and other fuel-related VOCs were generally low or not detected in most wells. The highest detected VOC concentrations were 250 micrograms per liter (μg/L) benzene, 5 μg/L ethylbenzene, 10 μg/L vinyl chloride, 31 μg/L 1,2-dichloroethane, and 1 μg/L trans-1,2-dichloroethene. The highest reported total chromium and lead concentrations in groundwater were 0.432 milligrams per liter (mg/L) and 0.915 mg/L, respectively. A more detailed discussion of the site contaminants can be found in the *Draft RCRA Facility Investigation Report, Charleston AFB, South Carolina* (Halliburton NUS, 1995).

Initial soil sampling prior to the one-year bioventing pilot test showed TRPH concentrations up to 2,200 mg/kg within shallow soils in the burn pit. Benzene was not detected in any of the soil samples collected but the compounds toluene, ethylbenzene, and total xylenes were detected in two of the three samples. Total volatile hydrocarbons (TVH) in soil gas ranged from 27 parts per million by volume (ppmv) to 790 ppmv. Ethylbenzene and xylenes also were detected at

very low concentrations in soil gas samples (Engineering-Science, 1993). The properties of suspected site contaminants are summarized in Table 4.1.

4.1.2 Site SS-41 Contaminants

The primary contaminants at Site SS-41 are petroleum hydrocarbons, which have been detected in the soils and groundwater. Soil headspace VOCs were detected with a PID in concentrations up to 3,311 ppm and with a total hydrocarbon analyzer at greater than 20,000 ppm. Volatile organic BTEX compounds are confirmed in soils at the test site, and VOCs and SVOCs are found in groundwater as well. Soil TPH was detected in prior sampling events. The only suspected source of these contaminants is JP-4 jet fuel. Previous investigations indicated that immiscible (free-phase) product may be present at the water table surface at the extreme north end of the site, but free-phase product has not been observed in existing monitoring wells.

Soil sampling was performed during the UST removals at Building No. 93 Fuel Pumping Station. The samples were collected around the former USTs and analyzed for various parameters including TPH, BTEX, and naphthalene. Several additional samples were analyzed for jet fuel fraction hydrocarbons and RCRA metals. BTEX compounds were detected in 47 of the soil samples. The highest detected benzene concentration was 7.4 mg/kg at a depth of 4 feet bls and the highest naphthalene concentration was 37.2 mg/kg. Detectable soil TPH concentrations ranged from 2.4 mg/kg to 1,180 mg/kg. Jet fuel hydrocarbon concentrations ranged from less than 10 mg/kg to 24,000 mg/kg. Detected RCRA metals and the highest concentration include: arsenic (20 mg/kg), barium (110 mg/kg), cadmium (1 mg/kg), chromium (10 mg/kg), lead (30 mg/kg), mercury (0.1 mg/kg), selenium (20 mg/kg), and silver (4 mg/kg).

Seven soil borings (SB-3 through SB-9) were advanced and sampled around the former Building No. 93 Fuel Pumping Station during the site assessment conducted by Parsons ES in 1995. The highest concentrations of fuel-related VOCs detected in soils included the following: benzene (1.7 micrograms per kilogram [μg/kg]); ethylbenzene (17 μg/kg); isopropylbenzene (2 μg/kg); naphthalene (25 μg/kg); tert-butylbenzene (2.7 μg/kg), toluene (2.7 μg/kg); m,p-xylene (110 μg/kg); o-xylene (56 μg/kg); 1,2,4-trimethylbenzene (34 μg/kg); 1,3,5-trimethylbenzene (43 μg/kg); and p-isopropyltoluene (6.1 μg/kg). The highest TPH concentration detected at the site was 44 mg/kg as jet fuel. Various chlorinated hydrocarbons also were detected in low concentrations in soils at the site, including the compounds 1,1,2,2-tetrachloroethane and 1,1,1-trichloroethane. Trichloroethene (TCE) was detected in all of the soil samples collected at this site, ranging in concentration from 4.2 μg/kg at SB-09 to 18 μg/kg at SB-06.

SVOCs were detected in two of the seven soil borings sampled at the site. In soil boring SB-6, benzo(b)fluoranthene was detected at 170 μg/kg and pyrene was detected at 210 μg/kg. In soil boring SB-7, detected SVOCs included: benzo(a)anthracene (790 μg/kg); benzo(a)pyrene (850 μg/kg); benzo(b)fluoranthene (1400 μg/kg); benzo(ghi)perylene (800 μg/kg); benzo(k)fluoranthene (500 μg/kg); chrysene (1,000 μg/kg); fluoranthene (1,800 μg/kg); indeno(1,2,3-cd)pyrene (870 μg/kg); phenanthrene (990 μg/kg); pyrene (1,900 μg/kg); and bis(2-ethylhexyl) phthalate (530 μg/kg) (Parsons ES, 1996).

Groundwater at the former Building No. 93 Fuel Pumping Station contains various fuel-related VOCs and SVOCs. Data from an October 1995 groundwater sampling event detected concentrations of VOCs and SVOCs only in monitoring well MW-11. The following compounds were detected in groundwater during that sampling event: benzene (86 micrograms per liter [μg/l]); ethylbenzene (25 μg/l); naphthalene (2.3 μg/l); toluene (84 μg/l); m,p-xylene

(98 μg/l); n-butylbenzene (1.8 μg/l); o-xylene (90 μg/l); p-isopropyltoluene (2.2 μg/l); phenol (13 μg/l); and bis (2-ethylhexyl) phthalate (2.1 μg/l). In addition, TPH as JP-4 was detected at a concentration of 4,800 μg/l in well MW-11. A later sampling event in November 1995 showed detections of fuel-related compounds in monitoring wells MW-11 and MW-12 at this site. In MW-11, BTEX compounds, bis (2-ethylhexyl) phthalate and TPH were detected. Bis (2-ethylhexyl) phthalate and TPH were detected in well MW-12 during this later sampling event (Parsons ES, 1996).

Three soil gas samples were collected and analyzed as part of the bioventing pilot study at the former Building No. 93 Fuel Pumping Station. The three soil gas samples were quantitatively analyzed for BTEX and TVH. Benzene was not detected in soil gas, however TVH concentrations of 21,000 parts per million by volume (ppmv) were detected at both VW2 and MPC (Engineering-Science, 1994).

4.2 PHYSICAL HAZARDS

Potential physical hazards at these sites include risks associated with auger drilling; electrical equipment; heavy equipment and trenching activities (including associated noise); motor vehicles; overhead utilities; underground utilities and fuel lines; slip, trip and fall hazards; and heat stress.

Safe work practices related to the site physical hazards are contained in Section 5 and 9 of the Program HSP, and are adopted for this site-specific HSP addendum by reference. Employees must implement safe work practices in accordance with OSHA regulations while working on the sites. In addition to the hazardous substances and environments present on the sites, other physical hazards may exist during installation of bioventing equipment, including risk of injury while working in or around equipment. Work areas should therefore be cordoned off to protect both public and operational personnel. Additional information concerning construction hazards is presented in the Program HSP and are adopted under this site-specific addendum.

4.2.1 Motor Vehicles and Heavy Equipment

In addition to the information provided in Section 5.2.1 of the Program HSP, the following precautions will also be taken:

- All personnel working at and around the drilling rig or other heavy machinery must be informed of the locations of the kill switches, in the event of an emergency.

TABLE 4.1
HEALTH HAZARD INFORMATION
SITE ST-03 (SWMU 55) AND SITE SS-41

Compound	LEL (%)	PEL/TLV (ppm)	IDLH (ppm)	Odor Threshold (ppm)	Odor Characteristics	Acute Toxic Effects	Chronic Toxic Effects	Fire Hazard	Explosion Hazard
Gasoline	1.2	300/300	--	0.25	Characteristic	Headache, dizziness	Suspected carcinogen, kidney	Dangerous	Moderate
Jet Fuel [1]	--	400/300	10,000	0.08			Liver, CNS, kidney	Dangerous	Moderate
Acetone	2.5	1000/750	20,000	--	Mint-like	Headache, dizziness, eye, nose, and throat irritation	Respiratory system, skin	Dangerous	Moderate
Benzene	1.3	1/10	3,000 (Ca)	0.1-300	Aromatic	Headache, dizziness, lassitude, inflammation, blistering, respiratory irritant	Human carcinogen, CNS	Dangerous	Moderate
Benzoic Acid	--	--	--	--	--	--	--	--	--
1,2-Dichloroethene	5.6	200/200	4,000	--	Acrid	CNS depression, eye and resp. tract irritation	CNS, respiratory system, eyes	Dangerous	Moderate
Ethylbenzene	1.0	100/100	2,000	0.25	Aromatic	Headache, eye irritation, skin irritation, upper resp. tract irritation	Upper respiratory system, CNS	Dangerous	Moderate
Lead	--	0.05/0.05 (mg/kg)	NA	NA	NA	Affects neuromuscular and central nervous systems	Suspected carcinogen, CNS, blood, kidney	None	None

[1] Based on exposure limits to petroleum distillates (naphtha)

TABLE 4.1
(CONTINUED)
HEALTH HAZARD INFORMATION
SITE FT-03 (SWMU 55) AND SITE SS-41

Compound	LEL (%)	PEL/TLV (ppm)	IDLH (ppm)	Odor Threshold (ppm)	Odor Characteristics	Acute Toxic Effects	Chronic Toxic Effects	Fire Hazard	Explosion Hazard
Methylene Chloride	14	100/50	5,000 (Ca)	--	Aromatic	Fatigue, weakness, light-headedness, nausea, eye irritant, skin irritant	Skin, CVS, eyes, CNS	Dangerous	Dangerous
Vinyl Chloride	3.6	1/5	Ca	--	Pleasant	Weakness, abdominal pain, GI bleeding hepatomegaly	Liver, CNS, respiratory system, blood,	Dangerous	Moderate
Trichloroethene	8	100/50	1,000 (Ca)	21.4-400		Anesthetic, eye irritant, nausea, vomiting	Suspected carcinogen	Dangerous	Moderate
Xylene	1.1	100/100	1,000	0.05-200	Aromatic	Upper resp. tract and eye irritation, dizziness, drowsiness, vomiting, abdominal pain, blistering and cracking skin	CNS, blood, kidneys, liver	Moderate	Moderate
Naphthalene	0.9	10/15	500	0.084	Mothballs	Eye, nose irritation, skin irritation; nausea vomiting	Liver, blood, RBC, CNS, kidneys,	Dangerous	Moderate
DEHP	0.3 (@474 ^{0} F)	0.3/0.61	Unknown (Ca)	0.25	Slight	Eye irritation, mucous membrane irritation	Eyes, GI, mucous mem.; carcinogen	Moderate	Moderate
Chromium	--	0.5/0.5 mg/m^3	30mg/m^3	--	None	Headache, eye irritation, skin irritation, upper resp. tract irritation	Upper respiratory system, CNS	Dangerous	Moderate
Arsenic	--	0.5/0.01 mg/m^3	100mg/m^3 (Ca)	--	None	Nasal ulceration, skin irritation, upper respiratory irritation	Liver, kidneys, skin, lungs, carcinogen	None	Low

SECTION 5

SITE-SPECIFIC EMPLOYEE TRAINING AND MEDICAL MONITORING REQUIREMENTS

The Parsons ES corporate health and safety manual and the expanded bioventing program HSP are incorporated by reference. Both manuals present general requirements for Parsons Engineering Science employee training and medical monitoring. All field team members will have the 40-hour Occupational Safety and Health Administration (OSHA) training as specified in Title 29, Code of Federal Regulations Section 1910.120 (29 CFR 1910.120) and a current 8-hour annual refresher course. All field team members will be on appropriate and current medical monitoring programs. Listed below are additional health and safety training and medical monitoring requirements for this project.

5.1 ADDITIONAL SAFETY TRAINING REQUIREMENTS

For Site SS-41, all persons who operate a motor vehicle inside the controlled flightline zone must attend flightline driver training (sponsored by Charleston AFB), pass a written examination, and obtain a flightline driver training certification prior to operating a motor vehicle on the flightline. Additionally, a vehicle placard is required for any privately-owned vehicle (POV) that enters the flightline zone. Access and egress from the Site SS-41 (former Building 93 fuel pumping station) project site will involve entrance into the controlled flightline zone. No person shall operate a motor vehicle at Site SS-41 without first obtaining the flightline driver certification and no POV shall enter the flightline zone without the required vehicle placard or a base-approved escort.

All Parsons ES team personnel engaged in site supervisory positions will have completed the 8-hour OSHA supervisory training as specified in 29 CFR 1910.120(e). All field team members must have site-specific training. Weekly safety briefings will be conducted if necessary.

The Site Safety Officer will be responsible for developing a site-specific occupational hazard training program and providing training to all Parsons ES personnel who are scheduled to work on-site. This training will consist of the following topics:

- Names of personnel responsible for site safety and health.
- Emergency contacts.
- Safety, health, and other hazards at the site.
- Acute effects of compounds at the site.
- Proper use of personal protective equipment.
- Work practices by which the employee can minimize risk from hazards.

- Safe use of engineering controls and equipment on the site.
- Decontamination procedures.

Time, place, and the list of participants (names, employee or social security numbers, and company names must be documented on the site training record located in Appendix B of the Program HSP.

5.2 ADDITIONAL MEDICAL MONITORING REQUIREMENTS

There are no additional medical monitoring requirements for the expanded bioventing sites on Charleston Air Force Base.

APPENDIX D
RESPONSE TO REGULATORY COMMENTS

RESPONSE TO SCDHEC COMMENTS

DRAFT FINAL CORRECTIVE ACTION PLAN FOR EXPANDED BIOVENTING SYSTEM IRP SITE FT-03 (SWMU 55) CHARLESTON AFB, SC (SC3 570 024 460)

SECTION I
Response to NOTI comments received from SCDHEC, Hazardous Waste Permitting Section (John Litton, P.E.), dated March 4, 1997:

Comment 1: *The Department considers this document to be an RCRA Interim Measures Workplan for SWMU 55. Please revise the Workplans Title and Introduction to reflect this.*

Response: The cover, title page and introduction were changed in the revised document to indicate that the document is an Interim Measures Workplan for SWMU 55. Clarification was added in the Introduction text that Site FT-03 is equivalent to SWMU 55.

Comment 2: *If the Air Force would like to use the analytical results of the "Option 2" sampling discussed in Section 4.5.3 as support of a final remedial decision:*

a. Sampling locations must (be) *determined by a random method (SW-846).*
b. Analytical methods must be in accordance with SW-846 and yield constituent specific results.

No response is required for this comment.

Response: This comment is acknowledged for future activities. No response is provided as directed.

Comment 3: *This plan does not address all Appendix VIII of R.61-79.261 hazardous constituents, therefore additional remedial work will be required at this site. No response is required for this comment.*

Response: This comment is acknowledged for future activities and it is being addressed by an ongoing RFI/CMS being conducted by Radian International under a separate contract. No response is provided as directed.

Comment 4: *It appears that an "Underground Injection Control Permit" from the Departments Bureau of Water may be required. Please address this issue.*

Response: An Underground Injection Control Permit (#127M dated 11/19/96) was issued by the Bureau of Water (BW) to construct the bioventing system as described. Pending a final system inspection by the BW, system Approval to Operate #127M is forthcoming.

Comment 5: *Attached comments from this Bureau's Hydrogeology section (Hargrove to Litton 02/18/97) must be addressed.*

Response: Specific comments from the SCDHEC Hazardous Waste Section, Division of Hydrogeology are presented and addressed in the following section of this Response to Comments document.

SECTION II

Response to review comments received from SCDHEC, Hazardous Waste Section (HWS), Division of Hydrogeology (Donald Hargrove), dated February 18, 1997. These responses incorporate the verbal discussions and clarification to these comments on February 19, 1997 between the SCDHEC-HWS, Charleston AFB, and Parsons ES:

Comment 1: *The Solid Waste Management Unit designation (SWMU 55) should be used in the title for tracking purposes. Please revise.*

Response: The cover, title page and introduction were changed in the revised document to indicate that the site is SWMU 55. Reference previous Comment #1 in Section I.

Comment 2: *There is no section in the document concerning cleanup criteria or RBCs. Proposed cleanup levels for the COCs at this SWMU must be proposed and approved by the Department. CAFB must be capable of remediating to these levels. Please revise the text as needed.*

Response: Identification of COCs and the proposed RBCs will be accomplished by other contractors (specifically Radian Corporation) during their ongoing RFI/CMS work at SWMU 55. The AFCEE Bioventing contract is not funded with the intention of establishing RBCs or providing regulatory cleanup negotiations. The contract is used primarily as a tool to accomplish soil remediation using a specific technology (i.e. bioventing) at sites where the technology has been successfully pilot tested. Text has been added to Section 2.2 (pg. 2-3) and Section 2.4 (pg. 2-8) stating that other contractors are performing RFI/CMS work and will be responsible for developing the cleanup RBCs.

Comment 3: *Table 3.1, Initial Soil Sample Laboratory Analytical Results: A comparison between this table and Table 3.2 shows some inconsistencies concerning MPD-3. a) Table 3.1 indicates nondetect readings for Benzene, Toluene, Ethyl benzene, and Xylenes (BTEX), while Table 3.2 shows numerical values with "less than" symbols but no qualifiers (e.g., values are below detection limits and estimated). b) The initial moisture content for MPD-3 on these two tables does not coincide Please revise these tables so that they are consistent.*

Response: Tables 3.1 and 3.2 were revised so that these data are consistent. References to "not detected (ND)" concentrations in Table 3.1 were replaced with the laboratory-reported method detection limits shown in Table 3.2.

Comment 4: *Table 3.5, Respiration and Fuel Biodegradation Rates: How were the degradation rates for these samples calculated? How can a degradation rate be*

calculated on the first sample taken at a particular location? The text should be revised to show the method used to determine these degredation rates.

Response: Fuel degradation rates are determined by conducting in-situ respiration tests at the vapor monitoring points. The respiration testing process used at this site is described in Section 3.2.5 (page 3-14) of the Draft Final work plan. The respiration test establishes an oxygen utilization rate in the soils, which is then converted to an equivalent fuel biodegradation rate based on the stoichiometric relationship for the mineralization (oxidation) of fuel hydrocarbons to carbon dioxide and water under aerobic conditions. The specifics of the fuel biodegradation physiochemical processes are discussed in the documents *Test Plan and Technical Protocol For A Field Treatability Test For Bioventing* (Hinchee et al., 1992) and *Part I-Bioventing Test Work Plan For Fire Protection Training Area Site FT-03* and *Part II-Draft Interim Pilot Test Results Report for Fire Protection Training Area Site FT-03* (Engineering-Science, 1993), previously submitted to SCDHEC-HWS for the bioventing pilot studies at this site. Text revision is not required.

Comment 5: *Section 4, Expanded Bioventing system: The third paragraph describes a "soil crown" to be installed over the proposed Vent Well (VW) trench and surrounding areas to promote drainage away from the new VW and the burn pit. The system detail provided in Appendix A do not show any proposed feature called a "soil crown". This soil crown should be shown in both map view and plan view, depicting both the horizontal and vertical extent of this proposed addition. Please revise.*

Response: The "soil crown" described in Section 4 (page 4-1), is the same feature as the "soil cap" shown in Drawing G-0.3 (Appendix A). Drawing G-0.3 illustrates in map view and cross section view the limits of the soil cap as it overlays the 10 mil polyethylene surface sheeting. The text "soil crown" on page 4-1 was replaced with "soil cap" to be consistent with wording used on the construction drawings in Appendix A.

Comment 6: *The text indicates that samples recovered from the MPD location show no signs of remediation while oxygen has been sufficiently raised. The text should address this inactivity in some way. Has the design of the new system taken this into account? Please revise the text to address MPD and the lack of bioremediation activity.*

Response: Initial and final samples collected from MPD showed a reduction of BTEX compounds and total volatile hydrocarbons (TVH) in soil gas after one year of bioventing. Respiration also was observed in soils at MPD after one year of bioventing, indicating that biodegradation is occurring. Results of soil sample analyses would initially suggest that no reduction of soil hydrocarbons occurred because the total recoverable petroleum hydrocarbon (TRPH) concentrations appeared to remain unchanged in MPD after one year of bioventing. In reality, soil samples are discrete point samples prone to large variabilities over a small area. For this reason, soil gas results and respiration testing are considered better

indicators of hydrocarbon remediation than limited soil sampling. Biodegradation is occurring at MPD, and no system modifications are required to continue oxygenating this area. Further discussion of the one-year bioventing pilot test results is provided in the pilot test completion report for Site FT-03 (SWMU 55) prepared by AFCEE (June 27, 1994). This pilot test completion report is included as Appendix B in the final work plan, and text was added in Section 3.2.1 to reference the completion report.

Comment 7: *What is the reasoning for leaving the tank within this SWMU since it is no longer used? Please revise the text to include removal plans.*

Response: As discussed previously, the empty tank is a mock-up aircraft that was used during fire training exercises. At its present location, the tank will not interfere with the proposed bioventing system expansion. Also, the AFCEE Expanded Bioventing contract does not have funds to remove this tank, so this work will have to be accomplished under other Air Force contracts. No text changes made.

Comment 8: *There is no text describing the installation of the expanded system. Section 4.4 describes the project schedule and Section 4.5 jumps to system operation, maintenance, and monitoring. A section should be added that describes upgrade of the existing system, as well as the installation of the new portion of the system. The installation description should include the following topics:*

a) There should be specific discussion concerning the bentonite surface cap. Will the entire cap be removed during the construction phase and subsequently replaced or will the cap be left in place? If the cap is left in place during construction, adequate measures should be included to describe how cap integrity will be maintained.

b) Excavation of the ditch for the horizontal well should be completely described. If shoring will be necessary or required given the local geology, the procedure should be added to the text. Are the contaminated soils to be excavated going to be placed in direct contact with the top of the surficial soil/plastic/bentonite cap (if cap remains during construction), or will the excavated material be placed on plastic on top of the cap?

c) The installation procedures for the horizontal well should be described to include:

i) Proper hydration of the bentonite.

ii) Compaction procedures and requirements for backfilling.

iii) Will the new underground air supply be grouted in place? Figure 3.2 shows the vertical casing exiting the ground surface through a grouted annulus, while Drawing G-0.3 describesw a grouted annulus without showing it graphically.

d) If the watertable is less than 3'6" below land surface (bls) during construction:

i) Will the ditch be pumped? If so, the pumped water should be treated as IDW and handled appropriately.

ii) Will construction be halted and the ditch backfilled?

Response: Section 4.3 (page 4-3) of the Draft Final work plan summarizes the design and construction of the expanded bioventing system. This section also references other site plans (Figure 4.1) and system design drawings (Appendix A) to provide the details of system construction so that a written description of these details is not necessary. The text is modified (where applicable) to clarify the issues raised in comments 8a-8d.

a) The pilot test vent well (VW-1) installed on the north side of the burn pit in October 1992 is the only VW that has a bentonite cap used as a surface seal. A similar bentonite surface seal is <u>not</u> proposed for the new horizontal vent well (VW-2) on the south side of the burn pit (plastic sheeting will be used as a surface seal for VW-2). Pilot test well VW-1 will be retrofitted with below grade piping so that it can be incorporated into the expanded bioventing system. This retrofitting work will disturb only a very small portion of the existing bentonite seal (approximate 1' by 5' area). Because the VW-1 bentonite surface cap is so thin in this area, there are no plans to replace it. This action is not expected to affect the performance of the vent well. No text changes were made.

b) Excavation of the shallow trench for the new horizontal vent well (VW-2) will be accomplished using a backhoe, equipped with a minimum 18" wide bucket. Based on the field results during construction of the pilot test vent well (VW-1), shoring will not be required to keep the shallow trench open. Additionally, no personnel will enter the trench until it is less than 3 feet deep, so that shoring is not needed to meet OSHA requirements. Additionally, excavated soils will be temporarily stockpiled on plastic and then placed back in the vent well trench for bioventing treatment. Section 4.3 was revised to indicate the trench construction method.

c)
  - i) Bentonite will be hydrated with clean water.
  - ii) A compaction specification (i.e. based on geotechnical test of soil density) will not be made for this project since there are no load bearing requirements for this soil. All backfill soil will be thoroughly compacted with a tamp. Text in Sectoin 4.3 was modified to reflect this.
  - iii) Figure 3.2 shows an as-built diagram of the existing pilot test vent well. The existing vent well will be retrofitted for below grade completion by removing part of the existing grout seal and attaching a new 2" air injection header pipe. This header pipe will not be grouted in place. Drawing G-0.3 shows the proposed new horizontal vent well. The 4" vertical riser pipe on this well will have a minimum 1-foot bentonite/grout seal. This seal is identified with text on Drawing G-0.3, but the symbol is missing graphically. This seal will be installed and the symbol will be corrected on the as-built drawings.

d) Prior to excavating the trench, several of the monitoring wells surrounding the burn pit will be gauged to determine the water table position. If the water table is less than about 3 feet below land surface (bls), installation of the new horizontal well will be postponed until the water table declines and there is no chance of precipitation. The vent well can be installed if a small quantity of groundwater

enters the bottom of the trench, as occurred during the pilot test vent well installation. No pumping of water from the excavation will occur.

Comment 10: *An approvable Site Health and Safety Plan should be included with this work plan.*

Response: A Site Health and Safety Plan was added to the document as Appendix C.